SCIENTIFIC AMERICAN SUPPLEMENT

Scientific American Supplement, Vol. I., No. 23.
Scientific American, established 1845.
New Series, Vol. XXXIV., No. 23.

NEW-YORK, JUNE 3, 1876.

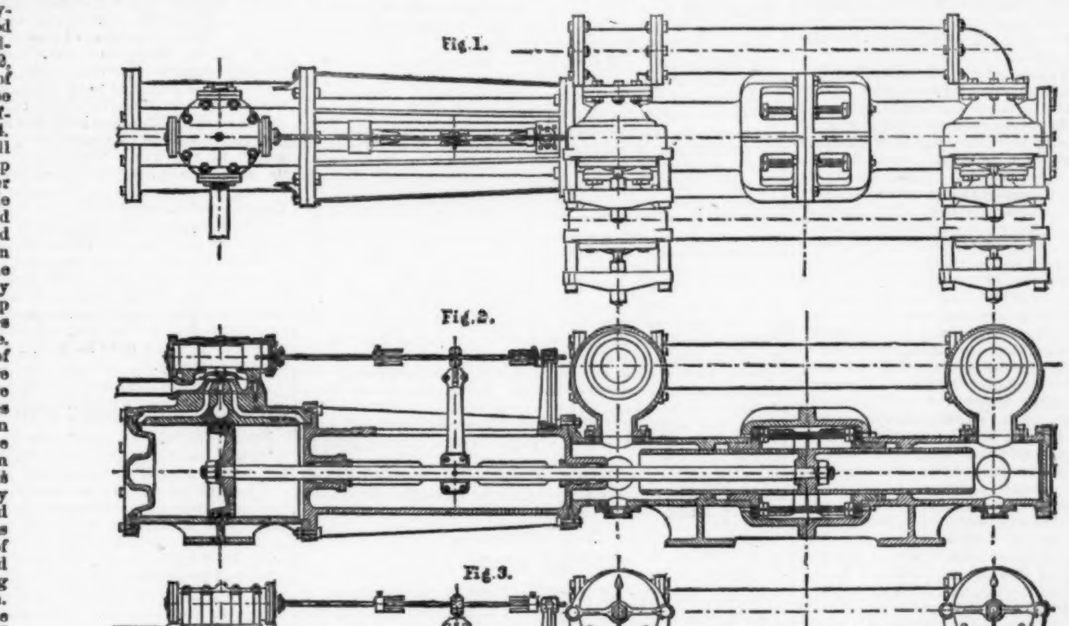
Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.
Postage free to Subscribers.

IMPROVED MINING PUMP.

WE give views of a steam pump constructed for use in the Ontario Mine, Utah, by Mr. William J. Silver, of Salt Lake City. The pump is of a similar pattern to one previously constructed by Mr. Silver for use at the well-known Emma Mine, and it is of interest as the production of a district where manufacturing engineering is as yet in its infancy. The pump illustrated has a 16-in. steam cylinder and 2-ft. stroke, the piston rod driving a pair of double plunger pumps with 8-in. rams. Last autumn the pump was working against a 200-ft. head and running at but 20 strokes per minute, that speed being sufficient to keep the water under; but the pump can of course be run at a higher speed, and it is also designed to work against a head up to 400 feet.

The arrangement of the valve regulating the admission of the steam to, and its release from, the steam cylinder will be understood on reference to the longitudinal section, Fig. 2, while the arrangement of the pump portion will be readily understood on reference to Figs. 1 to 4. From these views it will be seen that the two pump barrels are bolted together by flanges, and that the two plungers are connected by means of the piston rod as shown. The suction valves are situated at the side and the delivery valves at top of the pump barrels, and all the valves are very readily accessible.

The suction valves, of which enlarged views are given in Figs. 5 and 6, are india-rubber disc valves with thin iron plates on their backs, each valve sliding on a guide pin around which a spring is placed. The delivery valves on the other hand are flap valves arranged as shown in Fig. 4, each of these valves when lifted striking against a spring stop arranged as shown. It will be noticed that the covers of both suction and delivery valve boxes are each formed in one piece with the corresponding valve seat, and thus when the cover is removed the valve and seat come out together. The covers with the valve seats they carry are made circular, so that they are readily forced up to make tight joints on the inner and outer faces shown, while each cover is secured in place by a crossbar and pinching screw. This arrangement of valve seats and covers is a very neat one, and gives very convenient access to the valves.—*Engineering*.



MINING PUMP.—BY W. J. SILVER.

SUDDEN OUTBURSTS OF GAS.

AT the recent meeting of the Midland Institute of Mining Engineers a very interesting paper was read "On Dislocations in the Thill, with the Presence, Amount, and Tension of Gas in the Silkstone Seam of the Strafford Main Colliery, Barnsley," by Mr. R. Miller. The paper shows that even where no powder is used the best safety-lamps are an actual necessity to secure the safety of the workmen, and so to some extent disposes of the argument of the Home Secretary with respect to the safety-lamp itself. It appears that the first great outburst took place in the crack of the thill on Oct. 1st, 1867, and again on Aug. 31st, 1870, and has continued to give off gas ever since. The outburst in 1870 caused the floor to burst, there being sufficient gas to foul a strong current of air—10,000 to 12,000 ft. per minute on the face—to where it joined with 8000 ft. per minute more for at least four hours after first coming off. A bore-hole was put down to 74½ ft., and proved as follows: 23 ft. of very hard stones—bind and gray stone—in some parts so hard as to bore only 1 ft. in six hours; 13 ft. of mild bind, with ironstone bands; down to this 35 ft. no gas was given off; 16 ft. of dark bind, with a very little gas coming off irregularly; 3 ft. very dark bind, with increased discharge of gas, and at this depth (51 ft.) went through a few inches of shale and coal, with water in the bore-hole; 20½ ft. very dark bind, with coal-pipes and with thin bands of stone. This gave no increase of gas, but gives about the same discharge from 51 feet of depth to where the bore-hole is stopped at 74½ feet down from the coal.

The hole was 2¾ in. in diameter, and a gas-pipe of 1¼ in. was put down some 7 ft.; a steam-pressure gauge was put on, and in 35 minutes the gauge went up to 30 lbs. the square inch, and then, after a few seconds of rending and disturbance, the floor broke, and the gas spent at a crack some 2 yards from the hole, the gauge going back to 19 lbs. This proved that the floor at not less than 11 in. depth was rent, and that it required not less than 30 lbs. per square inch force to do it. Taking the thickness of 11 in., with 35 ft. thickness of hard stone, which overlay the soft measures charged with gas, suggests an almost unlimited force under that stratum so long as there was no continuous vent. A tested gas-meter was then procured, and the discharge was found to be 930 ft. in 88 hours, or 10½ ft. per hour. In November, 1870, the discharge of gas was 930 ft. in 88 hours, and at that time the gauge rose steadily for 50 hours until it got to 95 lbs per inch, and after having it up to 101 lbs. the valve was eased so that the discharge was free. The bore-hole was about 20 yards from the working face. From the end of 1870 till June, 1873, the hole continued giving off gas with increasing quantity, which Mr. Miller considered prevented another sudden outburst. Measured on June 11th to June 23d, 1873, it was found that the hole was giving off about 50 ft. per hour, or 14,120 ft. in 283 hours. From October, 1873, to the beginning of July, 1874, a daily register was kept, but the bore-hole was sealed a part of the time, and showed pressures ranging from 80 to 117 lbs. per square inch. At the end of September, 1875, the quantity of gas given off was rather over 20 ft. per hour, and at that date the faces advanced till the area of goaf was 9 a. 3 r. 22 p.

From the observations made, it appears that the pressure varied from 135 lbs. per square inch down to 80 lbs., whilst the highest pressure seemed to be always suddenly followed by the lowest pressure. From this it is evident that when at the highest the gas has been blown off, or has got vent in some way, and then gone down to the lowest pressure. It was suggested that in these cases of sudden outbursts the floor in some part of it may have been slightly rent and then discharge a small quantity of gas. Such might be possible, but nothing of the kind has been seen, though two sides of the goaf—the working faces and the side that is open to the return air-course—have always been watched and carefully examined. Mr. Miller, however, says it is more probable that when the gas has got to the greatest pressure the floor has been sprung or lifted over a certain space, making room for the gas to expand to a less force and density for the time, till the continuous discharge of more gas in time brings it up to its former power and pressure, as registered on the gauge. Though the pressure is great, there is no knowing how much greater it may become, for the extreme possible tension of gas as it is evolved from strata in the coal-measures is not known as yet with certainty. This much, however, these experiments prove with undoubted certainty, that in districts where the Silkstone seam of coal is being worked with a floor such as that described at Strafford Main, and which gives off no gas in the ordinary course of working, there is a force underneath which is equal to 135 lbs. per square inch above the weight of the atmosphere; and that without some tapping a release of this dangerous power either by stops in the hard floor, or by bore-holes or other means, the mine is, as it were, on the top of a heavily-pressed boiler, and as the coal is worked, the resisting power of the strata is reduced till an outbreak takes place.

CASE HARDENING.

A SUBSCRIBER writes us in relation to case hardening, wishing to know what material to use to effect the same, and if it can be done in an ordinary forge. "Case hardening" is the common expression for carbonizing. To carbonize is to harden or to convert from the normal state to a state many degrees harder. "Animal potash" is the best known agent for such purposes, although the ordinary potash will, in a measure, carbonize, but not so effectually as potash generated from animal substances. *Ferrocyanide of potassium*, although a little costly, is the most ready and effective agent known. Heat the surface to be carbonized sufficiently hot to absorb the potassium (pulverized), and again insert in fire and heat to "cherry red," when treat to bath of clear cold water. Remove scale with sand-paper or emery-cloth. The forge is as good a place to harden small or single subjects as a regular carbonizing furnace. In factories where much carbonizing is done, a cheaper potassium, "bone dust," is employed. The subjects are placed in an iron box and filled with bone dust, then placed in the furnace, and when sufficiently hot treated to the bath.

There are always many substances at hand, where carriages are built, which will serve for the purpose of carbonizing—leather scraps in abundant quantity will give off a sufficient quantity of potassium to do a fair amount of carbonizing; that is, make a fire of leather scraps and heat the iron with the same. Parings of horses or ox hoofs, or the hoofs of any animal, contain much animal potash, to which, if we add sodium, common salt, we make a very cheap and effective carbonizer. Vegetable potash, combined with animal fat in the shape of common brown soap, in which there is a proper amount of rosin, will also carbonize to a certain extent, simply by heating the iron hot enough to absorb the same, and again heating and treating to the cold bath.

Water mixed with *sodium* and *ferrocyanide of potassium* will carbonize to a fair extent any iron sufficiently hot, when plunged, to attract and absorb the sodium and potash.—*The Carriage Monthly.*

FRENCH ACADEMY OF SCIENCES.—APRIL.

On the Displacement of the Lines in Stellar Spectra. By Father Secchi.—It is generally admitted at the present time, that the displacement of a luminous point receding from or approaching an observer produces an alteration in the length of the luminous wave proceeding from the point. If this principle is combined with the principles of spectrum analysis, it follows that the lines in the spectra of substances existing in a moving star will be displaced, and hence the movement of the body in one or the other direction may be recognized. Father Secchi has prepared a table in which he compares the results of determinations of the motion of stars obtained by various observers, and these results he finds to be widely different and contradictory, so that in his opinion the processes of investigation require to be carefully reviewed. It appears: 1st. That at Greenwich Observatory observations are almost uniformly negative, positive results being an exception. (The minus sign is used to denote a receding, the plus sign an approaching star.) 2d. Results obtained on different days are not only discordant in point of extent, but are even relatively contradictory. 3d. The observations of Mr. Huggins mostly give similar values for a large number of stars. 4th. His results for the comet Coggia are not in accord with the movement of that comet elsewhere determined. 5th. The average values assigned by the different observations are greatly at variance.

In view of these differences, Father Secchi asks whether there may not exist, either in the mode of observation or in the instruments, a cause of systematic error which may produce the displacement of a line, without the knowledge of the observer. By actual experiments, he finds that *a line may appear instantly on one side or the other, according to the disposition of the spectroscope, unless the observer has an index sufficiently certain and accurate to recognize the illusion of which he is the victim.* This conclusion is obviously very grave. It is difficult to believe that so many eminent observers have made errors, but the fact remains that the latter are nevertheless possible. The exact cause of the above displacement Father Secchi has not determined, but he considers that it may be attributed to a kind of parallax due to the fact of the focus of the stellar image not coinciding with the plane of the slit in the instrument.

A New Theory of the Sun's Spots. By M. Gaston Planté.—M. Planté attaches to the negative pole of a secondary battery of 400 elements a piece of filtering-paper previously moistened with salt water. The positive wire is then brought in contact with the paper, when immediately below the wire there is produced a cavity in the form of a crater, the sides of which bristle with innumerable closely mingled filaments. At the same time there is a disengagement of vapor and production of light. The positive wire becomes covered with a magma formed by the transported paper pulp, and filiform *débris* adhere to the electrode for a distance of four or five inches.

It is impossible, says M. Planté, not to be impressed with the complete analogy of these electric perforations with those of the solar spots which have been of late observed by Nasmyth, Stone, Dunkin, Secchi, Langley, and others, which have been likened to twigs or bundles of stubble, twisted and interlaced. These strange appearances, so difficult to explain by ordinary mechanical action, are easily comprehended when the action of electricity is taken into consideration. M. Planté therefore believes that the solar spots are cavities produced by essentially electric eruptions; that consequently the interior mass of the sun is strongly charged with electricity; and that, according to the direction of the excavations of which the filamentous borders are turned inward to the interior of the orb, the electricity escaping therefrom must be positive.

In order still further to trace the analogy, M. Planté prepared globules of incandescent metal obtained by fusing large metallic wires by the aid of powerful electric currents. The liquid incandescent surfaces of the spheres appeared agitated, and covered with spots of all dimensions, produced by the gaseous bubbles coming from the interior. These bubbles developed so rapidly that it was difficult to note their different phases, but the umbra, penumbra, and bright portions characteristic of solar spots were nevertheless clearly distinguished, and they finally pierced the liquid envelope, and were projected into incandescent particles. The cooled spheres presented a surface covered with small tubercles, were hollow within, and their envelope was then in a degree proportionate to the gas in combination contained by the metal.

From this M. Planté further concludes: 1st, that the sun may be considered as a hollow electrified globe full of gas and vapors, and covered with a liquid envelope of molten incandescent matter; 2d, that the tubercles come from the undulations of the liquefied envelope; 3d, that the spots are produced by the eruption of masses of gas and electrified vapors from within; 4th, that the *faculæ* are a brilliant phase in the evolution of gaseous matters; 5th, that the protuberances are formed by the gases themselves bursting forth in incandescent state from the interior, and are naturally more luminous than those gases which form the atmosphere at the surface.

ROYAL MICROSCOPICAL SOCIETY.—APRIL.

THE President, H. C. Sorby, Esq., F.R.S., gave an admirably-managed soirée to the Fellows of this Society and other invited guests, including a large number of ladies. The extensive apartments of King's College were lent for the purpose. The entrance hall and staircase were decorated with choice palms, &c., by Miss Veitch, and abundant refreshments supplied in an upper room. This soirée was characterized by a pleasant absence of what are known as "shop objects," and the presence, in lieu thereof, of a fine and varied collection of slides, combining scientific interest with beauty of form and color. Numerous sections of minerals, including meteorites, iron and steel, blow-pipe beads and spectroscope preparations from the President's cabinets, were exhibited for him by Messrs. Ross, Beck and Browning, and Crouch. Mr. Lee illustrated the octopus, showing its eggs, palate, skin, eye, sucker, and Mr. Loy had a fine case of insect anatomy; Mr. Sanders brought preparations of ascidian tadpoles and other Fellows contributed numerous live objects. Among the minerals Mr. Hunt exhibited his famous diamond containing supposed organic remains. Mr. Hartley showed fluid cavities in quartz, and tourmaline containing liquid carbonic acid, which was alternately heated and cooled, to show its passage to the gaseous state and back again to the liquid one. Among new apparatus were Mr. Sorby's arrangement for accurately measuring the positions of absorption bands by reference to wave lengths; a new form of Stephenson's erecting binocular microscope, by Mr. Bevington, which appeared very handy for use, and another by Mr. Browning, adopting the Stephenson method to the Jackson model. In this instrument, the rays, which, when the stage is horizontal, pass vertically up the two main tubes, are reflected to the eye-piece tubes by two flats of silvered glass. When placed upon a table of suitable height, the observer looks horizontally through the eye-pieces—a position which the late Mr. Lobb, who was very skilful in exhibiting difficult objects, always advised, as involving least fatigue. We suppose this plan can be adapted to ordinary instruments upon the Jackson model. The one shown by Mr. Browning was of full-size, and made to carry all kinds of illuminating apparatus. Mr. Browning also showed a new portable microscope, avoiding the trouble and annoyance of screwing and unscrewing the body for use and packing. By an ingenious and firm arrangement, the body can be turned on one side and reversed, which enables it to go into a comparatively shallow box. When taken out of the box it can be adjusted in a moment, and stops secure it in the right position. For a travelling instrument it is admirable, and as convenient as others of the same size for home use. Captain Tupman exhibited a one-tenth objective, by Tolles, with a deep eye-piece, and Messrs. Powell and Lealand a remarkably fine one-sixteenth. Among the curiosities belonging to the Society, and displayed on the occasion, were spectacles of various powers used by Robert Brown in his botanical researches, showing what simple means sufficed, in his hands, for important discoveries; the famous Martin microscope, and a beautiful little instrument by Cuthbertson, on the reflecting plan of Arnici, in which inverted Newtonian telescopes of minute dimensions act as excellent objectives. Dr. Hudson gave a brief and interesting lecture in one of the theatres on Rotifers, illustrated in a new way by large transparencies illuminated from behind. Mr. Tisley showed Mr. Spottiswoode's Polarizing Apparatus, and Messrs. How & Co. exhibited various objects with an oxyhydrogen microscope. We should add that the collection of drawings, photographs, &c. (including a fine series by Messrs. Beck), was of more than ordinary merit and interest.

PHYSICAL SOCIETY, LONDON.—APRIL.

REFRACTION.

PROF. FOSTER exhibited and described an instrument for illustrating the law of refraction. It is founded on the well-known method of determining the direction of the ray after refraction by means of two circles described from the point of incidence as centre, the ratio of whose radii is the index of refraction. If the incident ray be projected to meet the inner circle, and through the point of intersection a vertical line be drawn, the line drawn from the point of incidence to the point where this meets the outer circle is the direction after refraction. This principle is applied in making a self-adjusting apparatus as follows:—A rod representing the incident ray is pivoted at the point of incidence, and projects to a point about 4 inches beyond. To this extremity is attached a vertical rod, which slides through a nut in another rod also pivoted at the point of incidence. The lower extremity of the vertical rod is attached to a link so fixed as to constrain it to remain vertical. By this means the two rods always represent respectively the incident and refracted rays, and the index of refraction can be varied by altering the position of the nut, through which the vertical rod passes, on the rod to which it is attached.

Prof. Foster then exhibited a simple arrangement for showing the interference of waves. It consists of two glass plates, placed one in front of the other, on each of which is drawn the ordinary sine wave. They are supported in a frame, and behind them is a paper screen, bearing lines to indicate the points of maximum and minimum displacement. The plates can be made to slide in opposite directions, and all the phenomena of wave motion generally and the state of the air in open and closed tubes can be shown.

SCIENCE NOTES.

On the Behavior of Alcoholic Yeast in Media devoid of Oxygen Gas.—Dr. Traube takes up this subject again in the *Botanische Zeitung*, to meet the objections to his conclusions raised by Dr. Brefeld. The latter says it is an absurdity to suppose that the albuminoids possess the power of supporting all the vital functions, as asserted by Dr. Traube, who retorts: "as though albuminoids could not produce living energy in decomposition in the same manner as sugar does in alcoholic fermentation." Further, Dr. Traube has repeated his experiments again in duplicate, and the result was increased rapidity in the production of the yeast in proportion to the quantity of albuminoids present when the germs were sown. He declares that Brefeld has refuted his own premisses and furnished the most convincing testimony of the accuracy of the statements he seeks to disprove. If we might regard the morphological labors on yeast as complete, Dr. Traube adds, we might say that "the reproductive cells of yeast (ascospores? gonidia?) undoubtedly require oxygen in germination; whereas developed yeast is able to make new growth in the absence of oxygen."

The Basidiomycetes.—In the last edition of his *Lehrbuch*, Sachs refers this group to his class *Carposporeæ*, although he remarks that no sexual organs or process had been observed in any of these fungi. Dr. Brefeld now publishes (*Botanische Zeitung*) the researches on the life history of the *Basidiomycetes*. Not to follow him through his experiments, we may mention that by a method of cultivation practised by him in former investigations, he professes to have observed them in every stage of development. And he asserts that he has determined by direct observation that the fruit-bodies of these fungi are not of sexual origin. Unfortunately, Dr. Brefeld devotes a good deal of space to an attack upon Van Tieghem, accusing him of appropriating his ideas, and publishing them as new. In a more recent number of the same periodical, Van Tieghem contributes some new observations on the *Basidiomycetes* and the *Ascomycetes*, supplementing an article which appeared last year in the *Comptes Rendus*. He affirms what Brefeld says respecting the absence of sexuality in the former group, and asserts that the same holds good for the *Ascomycetes*. Respecting Brefeld's insinuations of plagiarism, he good-naturedly repels them with dates, and expresses his great satisfaction that so keen an observer supports him in his views of the absence of sexual processes in these fungi.

Recent Contributions to Systematic Botany.—One of the most important works on descriptive botany in progress is Boissier's *Flora Orientalis*, the third volume and first part of the fourth volume of which were published towards the end of last year. The first volume was published in 1867, and the last part issued brings it down to the *Boragineæ*. The contents of the fourth volume are of more than ordinary interest, inasmuch as they include the *Compositæ*, and this large family attains its maximum in the region the vegetation of which is described in M. Boissier's work. It may be well to briefly define the area under consideration. Beginning with Greece it takes in European Turkey up to Dalmatia and the Balkan Range, the Crimea, Caucasus, including the northern slopes, Egypt and Arabia to the tropics, Syria, Asia Minor, Persia, Beloochistan, Afghanistan, and Southern Turkestan, to about 45° N. lat., cutting Lake Aral nearly in half. It would take us too far to say more respecting the general features of the flora of this region than that it comprises a vast number of peculiar species, and that a very large proportion of the plants are herbaceous perennials. Thus the *Compositæ* occupy 730 pages of the fourth volume, and embrace 1654 species, belonging to 172 genera. In Mr. Bentham's admirable paper on the distribution, &c., of the *Compositæ* (*Journal of the Linnean Society*, vol. xiii. pp. 335–577), the total numbers for the whole Mediterranean region are: genera, 143; species, 1918. This coincides with Boissier's region in the east, and includes, besides, the whole of North Africa to the Atlas, and the other two great European peninsulas, up to the southern declivities of the Pyrenees, the Cevennes, and the Alps. The discrepancy in the number of genera arises from a difference in the views entertained by the two botanists named regarding generic limits. Possibly, too, Mr. Bentham would have retained fewer species than the author of the *Flora Orientalis* has, though not to an extent to greatly affect the total number. Of the 172 genera kept up by Boissier, seventy are represented by a single species only; but there are several very large genera, which bring the average number of species per genus up to 9.6. The following thirteen genera furnish considerably more than half the total number of species:—*Inula*, 42; *Achillea*, 61; *Anthemis*, 93; *Pyrethrum*, 50; *Senecio*, 72; *Echinops*, 42; *Cousinia*, 136; *Cirsium*, 74; *Jurinea*, 44; *Centaurea*, 183; *Scorzonera*, 67; *Crepis* 62; and *Hieracium*, 50, making a total of 976 species.

The Pandaneæ.—This group still awaits a monographer to clear up not only the relationship of its members to each other, but also the position of the order. Some years ago Gaudichaud published in the *Atlas botanique du Voyage de la Bonite* excellent figures of a large number of Pandanads; but, unfortunately, no text accompanies the plates, and therefore subsequent botanists have found it difficult to adopt any of the fifteen new genera proposed by him for the species figured. There are even no indications whence they were obtained. To a recent part of the *Annales des Sciences Naturelles* M. Ad. Brongniart contributed some observations on the Pandanads of New-Caledonia, and, as he justly remarks, it is no more than fair to Gaudichaud to take up his genera where it is possible to recognize and define them; and at the end of the present paper he gives a list of the countries of the species figured by Gaudichaud so far as they are represented in the Paris herbarium. The few not included, he says, are probably in the herbarium of Delessert, now at Geneva, and in Webb's collections at Florence. This list will be very useful to future laborers in this field, and we mention it here because it is likely to be overlooked. Following the principle above given, Brongniart adopts two of Gaudichaud's genera, namely, *Bryantia* and *Barrotia*, founded upon the shape of the fruit, number of ovaries clustered together, and other particulars. Altogether, eleven species are described from New-Caledonia, two under *Pandanus*, seven under *Barrotia*, and two under *Bryantia*. The value of these can only be tested by a botanist working up the whole group.

INFLUENCE OF LIGHT AND HEAT ON SELENIUM.

PROF. W. G. ADAMS lately gave before the Physical Society, London, an account of some researches on which he has been engaged in connection with the influence of light and heat on the electric conductivity of selenium, and exhibited numerous experiments in illustration. The subject has also been studied by Lieut. Sale and Dr. W. Siemens of Berlin, and as a general result it is found that after it has been kept in the dark, the resistance of the metal is diminished by exposure to light. The effect, however, both of heat and light, is different in the several states through which the metal passes. Thus when a piece of amorphous selenium is gradually heated to about 100° C., kept at this temperature and slowly cooled, its resistance at first is so great that it can not be measured by the ordinary arrangement, but as its temperature increases, the resistance diminishes and increases again more slowly when the metal is allowed to cool. The resistance of several pieces which at the higher temperature were from one to three megohms were found to be from 100 to 130 at the ordinary temperature. If this selenium be placed in a paraffin bath and heated, its resistance diminishes, and when the temperature is kept constant above 140° C. for some hours and the metal is then slowly cooled, it assumes a crystalline structure, and its resistance *diminishes* as it cools. The resistance of such selenium at ordinary temperatures *increases* with the temperature. The effect is more marked as the temperature of the paraffin bath is increased. In studying the effect of light, the metal which had been heated to 140° C. was exposed to a candle at distances of 1, $\frac{1}{2}$, and $\frac{1}{4}$ metre; the initial resistance being 115,500 ohms. The readings in these three cases were 112,000, 108,700, and 101,500. Deducting each from the initial number we have 3500, 6800, and 4000 ohms as the changes of resistance due to exposure at these distances. Hence the effect of light varies inversely as the distance, or, what amounts to the same thing, directly as the square root of the illuminating power. These considerations have led Prof. Adams to suggest the use of selenium for comparing the illuminating powers of different sources of light, and he exhibited the arrangement which he proposes to use for this purpose. The action of light of different degrees of refrangibility was then exhibited, by allowing the light from several parts of a spectrum of the electric lamp produced by a bisulphide of carbon prism to fall on the metal, the remainder being cut off by means of a screen, in which there was a narrow slit. The violet light gave a deflection of about two divisions on the screen, the greenish yellow four, the orange red five and a half, and the deep red nine divisions. The effects produced by the greenish yellow and the deep red are at times nearly equal. It may easily be shown by raising the temperature of the metal that the effect of light on its conductivity is essentially the same in kind at a low and moderately high temperature. The fact that light and not dark heat produces the observed effect has been shown by sending the beam through solutions of iodine in bisulphide of carbon. A very small effect on the metal was always observed, but this may be assumed to have been due to light, as in all cases it was possible to see the form of the carbon points through the solution. This fact may also be strikingly shown by exposing selenium through which a current is passing to the flame of a Bunsen burner, first, when in its ordinary condition, and afterwards with the air openings at the base closed. It was shown that, whereas in the first case the effect produced was equivalent to three divisions of the scale, in the latter case one-tenth of the current produced by the exposure deflects the needle to the end of the scale. Prof. Johnstone Stoney then explained

the theory which he has suggested in explanation of the phenomena observed in the radiometers of Mr. Crookes, which has been published in the *Philosophical Magazine* for the current month. The theory rests on the supposition that there is an excessively small trace of residual gas in the sphere in which the moving discs are enclosed. When the apparatus is exposed to heat the blackened side of the disc is slightly warmed, and this warms a layer of air in contact with it. At the ordinary atmospheric pressure, Prof. Stoney assumes the layer so warmed to have the thickness of a sheet of paper, when the temperature of the disc is 20° C. above that of the surrounding air, and on such a supposition we may calculate it for any other pressure and temperature. If we diminish the pressure the thickness varies inversely as the pressure raised to the power ½. Thus if the disc be raised $\frac{1}{10}$ C. above the surrounding air, and the exhaustion carried to the $\frac{1}{100000}$th of an atmosphere, the layer will have a thickness of more than a decimetre, and the effect of the air will then be peculiar. If the gas is of such a density that the glass envelope is beyond the range of this action, the gas beyond the limiting distance will be cold, but if the effect reach the glass, conduction will take place to it. There will then be a procession of warm molecules towards the glass, where they will be cooled down, and form a number of cold, slow-moving molecules, which will go back to the disc and beyond it. And these processions will be intermixed with molecules taking no part in the action. In consequence of this, very few members will travel far in their paths; a portion of the motion of each, however, will be carried forward in the right direction. So long as these processions go on, the slow-moving molecules which reach the front of the disc are thrown off more vigorously than from the back. Prof. Stoney considers the pressure thus produced to be that measured by Mr. Crookes. With a pressure of the gas of $\frac{1}{10000}$th of an atmosphere, an elevation of temperature of $\frac{1}{10}$ C. will produce the force actually observed, while if the exhaustion be carried to $\frac{1}{100000}$th the elevation of temperature necessary will be $\frac{1}{10}$° C. Thus with the greater pressure a lower temperature will suffice, but other influences will then be brought into play tending in an opposite direction. It was pointed out that on this theory the action may be considered as closely resembling electricity, and Mr. Crookes has shown that the glass envelope is often itself slightly electrified.

LIQUID CARBONIC ACID IN MINERALS.

By WALTER NOEL HARTLEY, F.C.S. (King's College, London).

Read before the Royal Microscopical Society, March 1, 1876.

IN 1822 Sir Humphrey Davy investigated the contents of fluid cavities in rock-crystals from different localities. His researches showed that in almost every case the liquid was nearly pure water.

About four years ago I bought from Mr. Norman, of the City Road, a microscopic slide of quartz with fluid cavities. One good sized cavity was readily seen with a 2-inch objective; it exhibited when under the microscope the shape and appearance of Fig. 1. Its entire length was $\frac{1}{15}$ of an inch, and its average breadth $\frac{1}{125}$ inch. The liquid at once recognized is indicated by *b*.

Being acquainted with the experiments of Cagniard de la Tour, I resolved to repeat them with this specimen, and therefore, proceeding cautiously, warmed the slide over a lamp, until it was just too hot to be touched with comfort. On examination, the liquid, to my surprise, was not to be seen, and the cavity under these circumstances appeared like Fig. 2. As the temperature to which the fluid had been subjected was but little above that of boiling water, I concluded that it had escaped from some minute and invisible opening; continuing, however, to observe the object until it became cold, I was gratified to see a sort of flickering movement within the apparently empty space of the cavity, followed by the replacement of the liquid, as at first. The extremely low temperature at which only the substance assumes the liquid state, made me at once desirous of ascertaining the exact conditions under which the liquid is dissipated and reproduced; for the researches of Professor Andrews, "On the Continuity of the Gaseous and Liquid States of Matter," have told us that at a temperature of 88° F., or 30°.92 C., liquid carbonic acid becomes a gas, and a pressure of even 300 or 400 atmospheres will fail to condense it to liquidity. This temperature is called the critical point. To determine the critical point of the new fluid, immersing the slide in water of known temperature, removing, wiping it hastily, placing it on the microscope stage, and instantly examining it, seemed preferable to any other mode of operating, and although other more promising methods have been tried, the results obtained have been less accurate.

1st Experiment.—The liquid in the two cavities had disappeared completely at 36° C.; the cavities appeared empty, but the liquid returned after a short interval. 2d. The liquid had totally disappeared at 31°.5, and returned on cooling. 3d. The liquid was invisible at 31°, but returned almost immediately after contact with the microscope stage. 4th. At 31° there was no liquid to be seen, but it was observed to be filling in immediately afterwards. 5th. Again at 31° did the liquid vanish. 6th. At 30°.75 the margin of the liquid was visible, but was not so sharply defined or so high up in the cavity as it afterwards became. 7th and 8th. On being warmed almost to 31°, the liquid was still visible, but the margin became more distinct immediately afterwards. 9th. At 31°.5, liquid invisible. 10th. At 31°, upper portion of the liquid invisible; lower one not. 11th. The liquid invisible at 31°, in the upper cavity, but not in the lower. 12th. At 30°.75 the liquid was seen in the larger cavity; the quantity, however, increased to treble immediately afterwards. 13th. At 31° the upper cavity appeared empty; the lower one full. It is evident, then, that the critical point lies between 30°.75 and 31° C. The critical point of pure carbonic acid, as determined very precisely by Andrews, lies at 30°.92 C., or very nearly 87°.7 F. Hence I conclude that the identity of this liquid with carbonic acid is established in a most convincing manner. It was noticeable that in whatever position the slide was placed, the liquid generally condensed on the same spot. Varying the method of heating the liquid by applying a hot wire to the surface of the quartz, I discovered what was at first by no means apparent, namely, that the upper and lower cavities were connected by a small fissure, and that water occupied the intervening space; the upper cavity was then seen to have the shape drawn in Fig. 3, and marked *a*. This presence of water, no doubt, determined the place of condensation, so that no matter what the position of the specimen, the carbon dioxide always condensed on the surface of the water, because of its adhesion to this fluid being greater than to the quartz. The concavely curved surface of the carbon dioxide is due to adhesion to the moist sides of the cell; the convex curvature indicating where the two liquids are in contact is caused by the greater adhesion of the water to the same surface. Before the specimen had been heated in such a way as to drive the liquid from the smaller into the larger cavity, it contained more of the carbonic acid than has collected in it since, and it was noticed on two or three occasions, that the action of heat was to diminish the gas-bubble very rapidly, by expansion of the liquid, until it had the appearance shown in Fig. 4; the bubble then as quickly increased in size, *by contraction of the liquid* to its original dimensions, when the source of heat was removed; likewise, when the heat was continued, the gas-bubble increased by *vaporization of the liquid*, as in Fig. 2. The appearance caused by the expansion and contraction resembled the dilatation and contraction of the pupil of the eye. Since the connection between the cavities has been made by excessive heating, the expansion and contraction cannot be shown; the liquid at once begins to vaporize, when warmed, and even boils, as is shown in Fig. 4. The following observation of Thilorier explains this. When a tube containing liquid carbonic acid is one-third full, at 0° C., it constitutes a *retrograde thermometer*, in which increase of temperature is shown by diminished volume, consequent on the vaporization of the liquid, and *vice versâ*; while if the tube be two-thirds full, a *normal thermometer* of great sensitiveness is the result, the liquid expanding by heat in this case.

Very careful observation several times repeated has shown that on the approach of a warm substance, causing the liquid in the larger cavity to be vaporized gradually, the curvature of the surface in contact with the gas becomes reduced very much, and at the same time rendered less plainly visible, as shown by *b*, Fig. 3.

There was also noticed a faint flickering shadow in the point of the cavity, when the liquid was about to condense. Professor Andrews has noticed such effects during the vaporization and condensation of liquid carbonic acid. In the same section of quartz there were observed upwards of fourteen smaller cavities, containing liquid carbonic acid, together with water in different proportions. There are two such cavities shown in Fig. 1; in each case the space marked *a* contains carbonic acid as gas; *b*, the same substance liquefied and floating on the water, which, being indicated by *c*, is seen to be occupying the remaining space,

According to Thilorier, the specific gravity of liquid carbonic acid is 0.83 at 0° C., and 0.6 at 30° C., water being taken as unity. The constant position of this liquid in the cells being uppermost is in accordance with this.

Volatile fluids have been noticed in mineral cavities by Sir

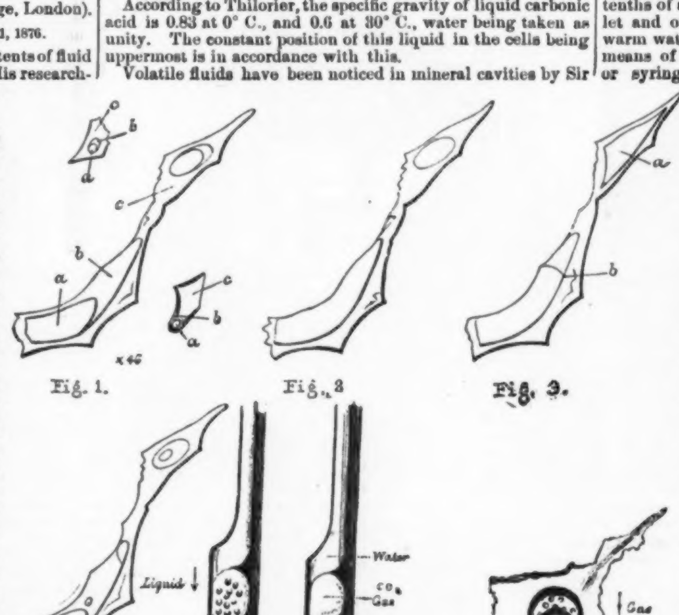


Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 6. Fig. 5. Fig. 7.

LIQUID CARBONIC ACID IN MINERALS.

David Brewster, by the late Mr. Alexander Bryson, and by Messrs. Sorby and Butler, who came to the conclusion that the liquid in a particular cavity in a sapphire was really liquid carbonic acid, because it possessed a remarkable rate of expansion between 0° and 30° C. Thilorier has shown that the expansion of liquid carbon dioxide between 0° and 30° C. is such, that 100 volumes become 145. Sorby found that 100 volumes of the liquid he examined became 150 at 30° C., 174 at 31° C., and 217 at 32° C.

Through the kindness of Mr. Butler, I have had the advantage of examining some of the best specimens from his unique collection of stones with fluid cavities, and I have no doubt that the conclusion which he and Mr. Sorby arrived at was a just one. By a very simple contrivance I have been enabled to detect the presence of liquid carbonic acid in many very small cavities containing water. This consists of a glass tube about three eighths of an inch in diameter and twelve inches long; it is drawn out to a jet at one end of about one sixteenth of an inch aperture, the jet being bent at an obtuse angle. To prevent the glass being softened and bending when heated, it is covered for four inches in its central part by a piece of brass tube, which slides on not too easily. The straight end of the tube is somewhat pointed, and passes through an india-rubber cork fitting into a universal joint upon a stand having a sliding motion in the upright so that it may be raised or lowered at will. This end of the glass tube which has passed through the cork has a piece of india-rubber tube slipped over it fifteen inches long, and to this is attached a ball syringe whereby air may be drawn in and discharged again. By heating the metal tube with a spirit lamp or Bunsen burner, the air discharged will be heated and may be directed on to the object while undergoing examination beneath the microscope without any displacement whatever, by which means a high power may be used for the examination of small cavities. By noticing the number of ballfulls of air necessary to vaporize a known specimen of carbonic acid, one may, if these be sufficient to vaporize the liquid in small cavities, be certain that the temperature is not greatly different. It is easy to demonstrate the presence of small quantities of carbonic acid mixed with water in cavities no larger than $\frac{1}{1750}$ of an inch in their greatest diameter.

After carbonic acid has passed its critical temperature, if it be cooled suddenly it condenses with a motion resembling ebullition. This is best seen in deep cavities. Messrs. Sorby and Butler have observed this phenomenon. Having attentively studied it in different cavities, I have come to conclusions as to the meaning of it. When the gas is chilled, a sort of mist forms throughout the space; the individual spherules of this mist grow so large that they begin to touch each other, to coalesce, and to gravitate. They of course at the same time entangle gas, and as they descend to the lower part of the cavity the spherules of gas (bubbles) take an opposite direction; consequently when a portion of the liquid has collected at the lower end and gas at the upper, there are showers of liquid descending into and streams of bubbles rising out of the liquid. In two or three seconds the movements have ceased. In Figs. 5 and 6 are given representations of a fluid cavity in topaz belonging to Mr. James Bryson, of Edinburgh, to whom I am much indebted for allowing me to examine some of his valuable specimens. When at a temperature two or three degrees below the critical point, the liquid has the appearance seen in Fig. 5, but the boiling is shown in Fig. 6—the *spherules* called *gas* and *liquid* are passing in the direction of the arrows nearest them. The drawing, Fig. 7, represents a cavity seen in one of my specimens of quartz; the contents are undergoing the apparent boiling. The conditions favoring this singular mode of condensation seem to be, first, that the greater part of the carbonic acid shall be in the liquefied state, at ordinary temperatures, so that the liquid expands greatly on approaching the critical point; second, that the cooling shall be sudden.

Cavities containing liquefied carbonic acid may be divided into two classes, *wet* and *dry* cavities, according to the absence or presence of water. The appearance of the liquid in a dry cavity differs much from that in a wet one. Thus in a dry cavity the liquid presents a convexly curved surface to the gas, in a moist one a concave surface. While the carbonic acid in sapphires and rubies seems generally to be dry, that met with in quartz and other minerals is more frequently wet.

Another means of ascertaining the critical temperature of the liquid in fluid cavities was resorted to. It consisted in making a water-tight cell with glass sides, which would contain, besides the mineral under examination, the bulb of a small thermometer three inches in length and graduated into one tenths of a degree Centigrade, between 29° and 35° C. An inlet and outlet tube of india-rubber conveyed a stream of warm water, forced through the cell from a small flask by means of the pressure of a large india-rubber finger-pump or syringe. The entrance and exit for air to and from the syringe was by valves in different branches of a **T** tube.

The walls of the cell were made by boring a hole an inch in diameter through an india-rubber cork of the diameter of 1½ inch. Two perforations one eighth of an inch in diameter were made in the side of this to admit the water tubes, and a third for fixing the thermometer in. The glass slides placed top and bottom of the ring were firmly fixed by passing stout india-rubber bands over them. When the cell was placed on the microscope stage, a powerful Coddington lens was so arranged in position near the thermometer that without the slightest movement the cavities could be watched through the microscope with the left eye, and simultaneously the mercury in the thermometer with the right. The cavity under examination was so arranged that it appeared just upon the edge of the lens. Admirable though this arrangement seems, it does not answer quite so well as one might expect. The volume of water in the cell is so small that it changes temperature more readily than the slowly conducting mineral.

My original plan of immersing the mineral in a considerable volume of water at temperatures just above and below the critical point, may be improved upon by placing the specimen in a glass cell with parallel sides and immersing this in water of known temperature; on removing this for examination, the sides of the cell may be wiped dry without fear of the mineral losing an appreciable amount of heat. Being now engaged in the study of other rocks and minerals, details regarding these had better be left for another communication. I have elsewhere shown the nature of the chemical reaction which would most probably yield quartz crystals with carbonic-acid cavities, but this explanation could not be applied to the formation of topaz and sapphire.

MANUFACTURE OF SULPHURIC ANHYDRIDE.

By Dr. R. MESSEL and Dr. W. SQUIRE.

A PAPER on this subject was lately read before the Chemical Society, Professor Andrews, F.R.S., in the chair, April 20th, 1876. The speaker, after giving a sketch of the history of the manufacture of sulphuric acid, described their process for preparing the anhydride. The vapor of ordinary sulphuric acid is passed through a white-hot platinum tube, whereby it is almost completely decomposed into water, oxygen and sulphurous anhydride; the mixed gases, after passing through a leaden worm to condense the greater portion of the water, are completely dehydrated in a leaden tower filled with coke, over which a stream of concentrated sulphuric acid is allowed to trickle. The dry mixture of oxygen and sulphurous anhydride is now passed through a platinum tube heated to low redness, and containing fragments of platinized pumice, when the gases recombine to form sulphuric anhydride, which is condensed in a series of Woulffe's bottles.

The chairman thanked the authors, and in allusion to a remark of theirs on the difficulty of condensing sulphuric anhydride when mixed with air, said that in the case of a mixture of equal volumes of air and carbonic anhydride, the latter did not condense even at a most enormous pressure, but on lowering the temperature to 0 deg. C. the carbonic anhydride was condensed.

Dr. Armstrong remarked that the authors had spoken of the Nordhausen acid as a solution of sulphuric anhydride in sulphuric acid; but it was in reality a definite compound which yielded definite salts, and also a corresponding chloride. It might, perhaps, be called pyrosulphuric acid.

In reply to an observation by Mr. Spiller, Dr. Squire said the Nordhausen acid made in Bohemia was of two strengths, but all the samples he had examined had a sp. gr. considerably below 1.900

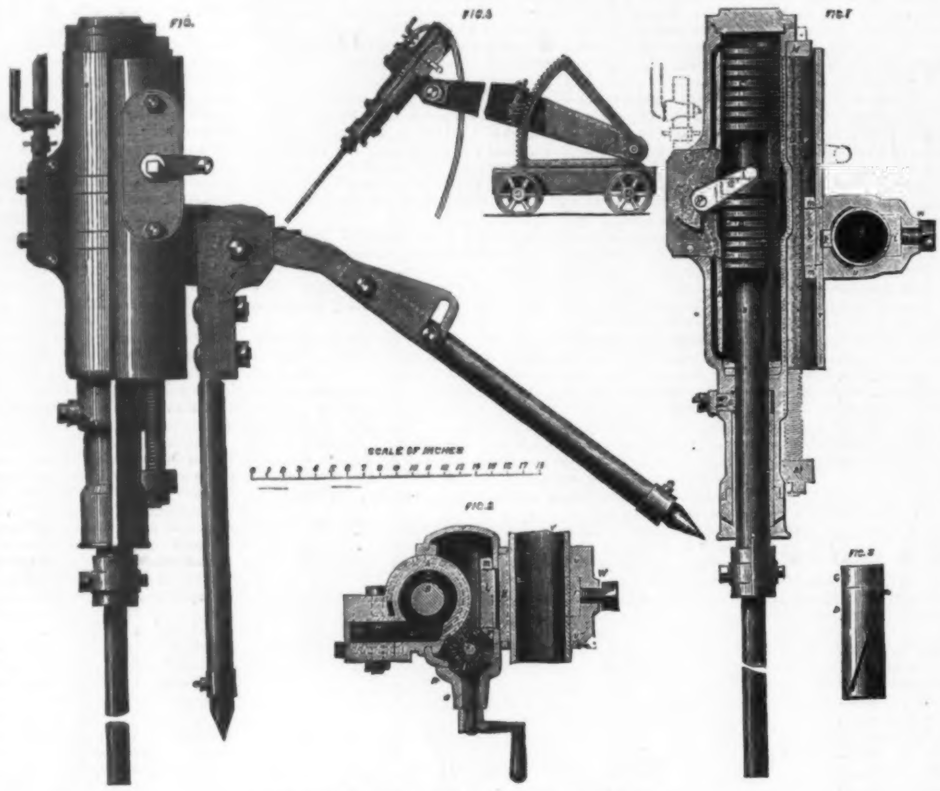
THE KAINOTOMAN ROCK-DRILL.

This machine, by Messrs. Brydon & Davidson, Whitehaven, England, has now been in use for upwards of two years.

It consists of a cylinder A, Figs. 1 and 2, of uniform diameter, fitted with two pistons C C. A tappet C', Figs. 1 and 2, the head of which, *h*, forms the valve, is actuated directly from within the steam chest on the sides of the steam ports, and between the pistons, thereby dispensing with the use of external valve-rods, stuffing-boxes, and other parts. In order to give a partial rotation on its axis to the cutting or boring-tool on its return or upstroke, a tube, D, Fig. 3, is provided within the lower end of the cylinder, having a spiral groove *a*, Fig. 3, formed therein, within which groove works a suitable projection or feather in connection with the piston-rod B, Figs. 1 and 2. On the upper end of the tube a number of ratchet teeth are cut at C; and in order to prevent the piston or piston-rod from rotating in its forward or downward stroke, a catch or pawl, *e*, Fig. 1, is forced forward by a spring into the teeth on the tube, and allows the tube to turn freely, but holds it firmly during the backward stroke.

The cylinder is provided with a screw running parallel thereto and fixed to lugs or projections M M, Fig. 1. On this screw works a travelling nut, N, carrying a mitre-wheel, O, into which gears another mitre-wheel, P, fast on the spindle Q, which has a handle attached to it. U is a clamp through which passes a cylindrical bar, V, provided with two gripping-plates, *i* and *k*, at the top and bottom or opposite sides so contrived that by a single set-screw, W, the machine can be screwed to any angle and as readily released. For this purpose the clamp is formed with a projecting screwed boss, *l*, which enters the jacket T on the cylinder, and is screwed therein by means of a screwed collar, *m*. The clamp U and jacket T are made a working fit, so as to allow the machine to be turned freely on the boss *l* to any vertical angle desired when released by the set-screw W. The releasing of the set-screw W also allows the machine to be turned or adjusted on the cylindrical bar V to any desired horizontal angle; on tightening the set-screw again the bar V will be gripped firmly between the gripping-plates *i* and *k*, thus securing the clamp on the bar, while at the same time the gripping-plate *k* will, by being pressed against the surface of the jacket T at its ends, tighten the clamp in the jacket; thus a double grip is obtained on tightening the set-screw, and both the grips are simultaneously released on loosening the same screw. The machine is erected either on a tripod, as shown in Fig. 4, or on a carriage, as shown in Fig. 5. The construction of this carriage which is also patented by Messrs. Brydon & Davidson, will be partly understood from the drawing. In addition to the vertical motion of the jib which is given by the endless screw, provision is also made for lateral motion to any extent, as the quadrant to which the jib is affixed is carried by a small turn-table, so that the drill can be set at any angle that may be required.

The Kainotoman may be regarded as a modification of the American Burleigh rock-drill, with which it has some points in common. As will be seen, the reciprocating and rotating motions are alone performed automatically, the feed being given by hand, and thus the tool is not so liable to break on a sudden transition from a soft rock to a harder. This drill is recommended for its simplicity, the small number of moving parts, and its relative lightness.—*The Engineer.*

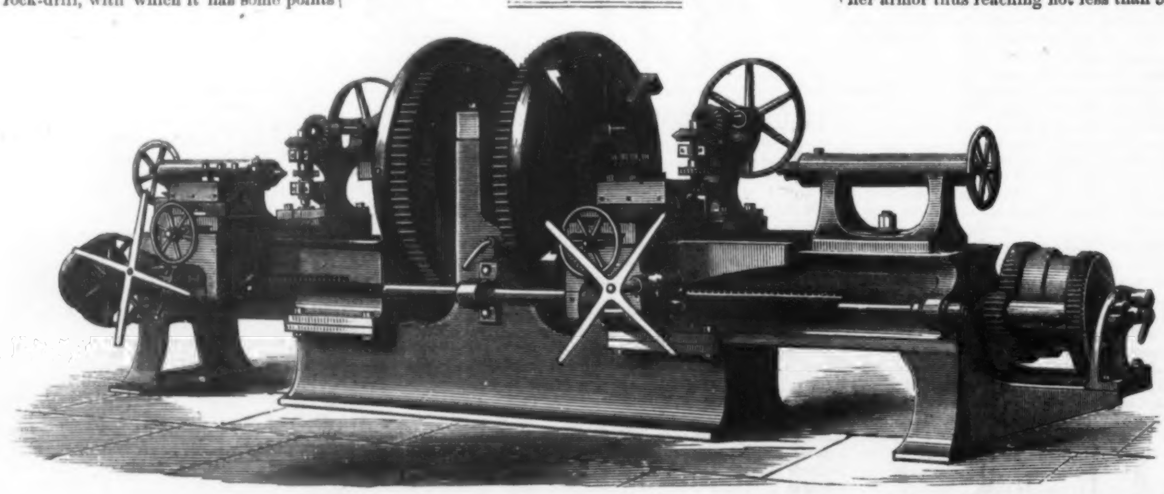


THE KAINOTOMAN ROCK-DRILL.

PROGRESS OF MARINE STEAM-ENGINEERING.

Mr. J. R. Ravenhill, in a recent paper before the Institute of Naval Architects, said:—

There are, doubtless, some amongst my audience who have only just commenced their career in connection with the marine steam engine and they find large engines being constructed to work at a pressure of 70 lbs. on the square inch, with a speed of piston of 560 ft. per minute, and they perhaps scarcely realize to the full all the difficulties that arise in obtaining such high results. I venture for one moment to draw their attention to what my own memory carries me back to when I was in their position some thirty-five years ago. At that time the Royal Mail Company's fleet was just commencing its service, and the wonders of the day then were large paddle-wheel beam engines, such as were constructed on the Thames, the Mersey, and the Clyde; those by Miller, Ravenhill & Co., constructed at Glasshouse Fields for the Trent and Isis, belonging to the above-named fleet, of 400 horses nominal power, cylinders 74 in. diameter and 7 ft. stroke, working collectively up to an indicated power of 770 horses, fitted with flue boilers, the safety-valves being loaded to 4 lbs. on the square inch, and the pistons travelling at 230 ft. a minute. Compare such machinery with that I have been giving you a short outline of, and if progress so great has been made during the past, depend on it much more will be expected during the future. In conclusion, there is one thing that requires the close attention of all those connected with marine engines. As a matter of absolute necessity in all high-pressure boilers for the royal navy, fitted with return tubes over the fireplaces, the steam space above the water line is very limited in its cubic contents, and the area of water level in this class of boilers is of necessity much contracted, and serious trouble when the boilers were being forced to their utmost has been experienced by the excessive priming that has taken place, and until the vessels have been at sea for some little time. There appears to be no known cure at the present time for this malady.



COMBINED BORING, TURNING, AND GROOVING MACHINE.

COMBINED BORING, TURNING, AND GROOVING MACHINE.

We illustrate a combined duplex boring, turning and key-bed grooving machine, designed by Mr. Martin Atock, locomotive superintendent of the Midland Great Western Railway of Ireland. The machine is especially intended for railway carriage and wagon-wheel and axle work, and it is particularly adapted for small shops where there is not sufficient work to be done to continuously employ a series of machines for carrying out the operations which this combined machine can perform.

The machine resembles in general design a couple of gap-lathes—right and left handed—placed end to end, the central headstock serving for both lathes. This central headstock has a hollow spindle, through which an axle can be passed, this spindle carrying a couple of face-plates of a size sufficient to carry railway carriage or wagon tires for boring, &c. Two tyres, or two wheels, chucked on these face-plates can be operated upon simultaneously. An axle mounted on the machine can also have both ends operated upon at once, as in an ordinary double-axle lathe.

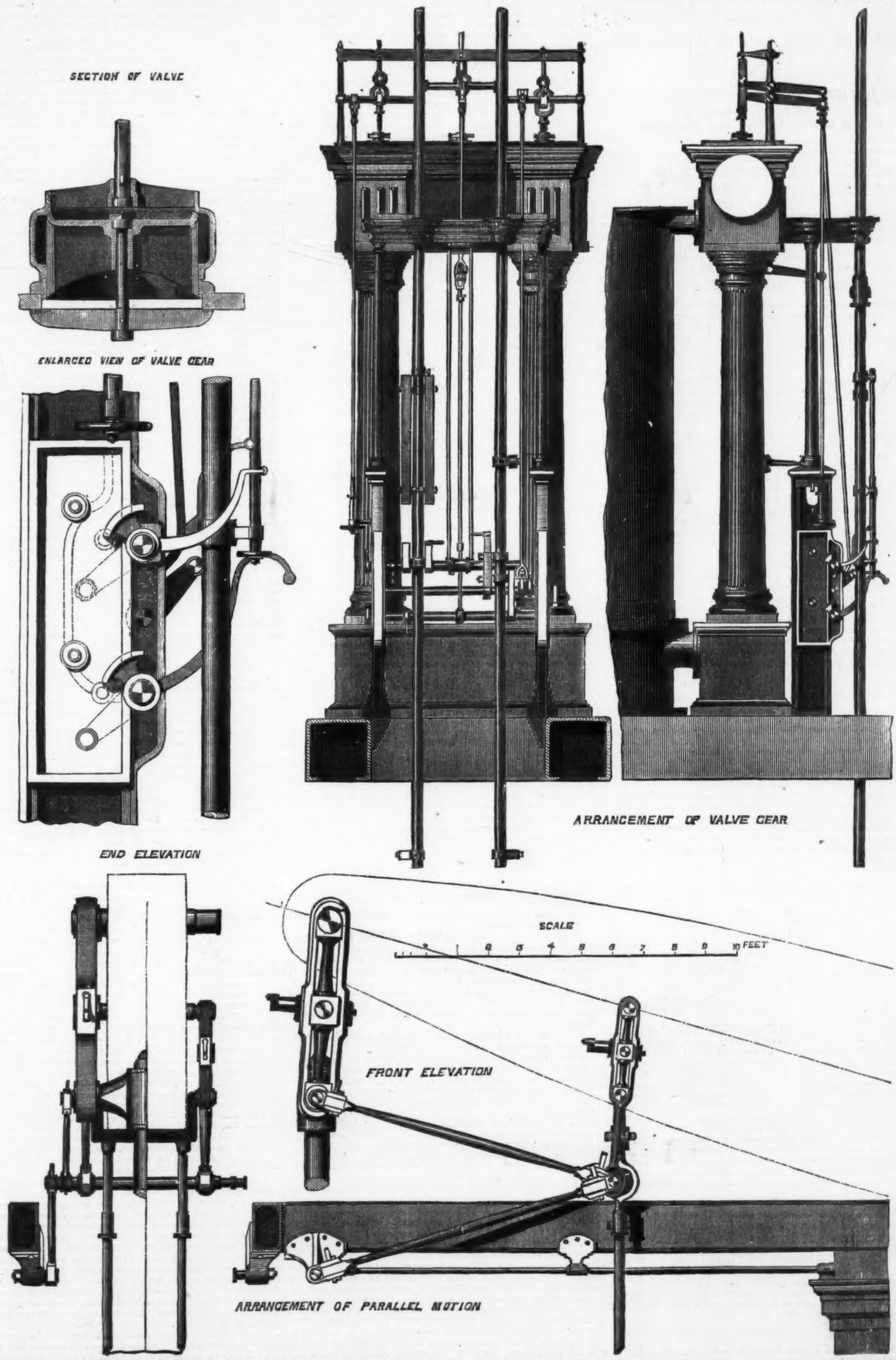
For cutting keyways, each slide rest is provided with a slot-drilling head as shown, the drill spindles being driven by separate belts from an overhead strap. The traverse of the slide rests gives the necessary traverse to the drill-spindles (this traverse being, of course, self-acting), and thus the tool forms an efficient double-axle grooving machine. Messrs. Shaw, Hossack & Co., of Openshaw, Manchester, are the makers.

THE INFLEXIBLE.

This monster war-ship was successfully launched at Portsmouth, Eng., April 27th.

The Inflexible is the largest war-ship ever launched. With the exception of the Great Eastern she is, we believe, the largest ship in the world, her calculated displacement being not less than 11,407 tons. Amidships is constructed a citadel, 100 ft. long and 75 ft. wide, which will protect the bases of two turrets, in each of which will be mounted two 80 ton guns. The walls of the turrets will be protected by 18 in. of solid iron. The sides of the citadel will be armored with two thicknesses of plate, making together 24 in. of iron, a space of about 2 ft. 6 in. intervening between them, which will be filled up with timber backing. We have here a scheme long and persistently advocated in this journal, imperfectly carried out. We have explained that although a shell may pierce a solid plate of considerable thickness, it by no means follows that it will pierce two plates of even less thickness in the aggregate, provided a space of a few feet is left between them. The first plate will explode the shell, and nothing but fragments will be left to strike the second plate. In the case of the Inflexible what should be an air-space has been filled with wood, and it is to be feared that this wood may so far keep the fragments of a shell together that but a very small area of the inner plate will have to sustain the whole force of impact of the broken projectile, as well as that of the exploding charge which it contains, and that, as a consequence, the head at least of the shell may find its way through, or if not, that the inner plate will, at all events, sustain serious injury, which it would have escaped had the fragments of the shell been allowed space in which to spread a little. There is besides a probability that the explosion of the shell charge may peel off the outer armor plate by driving it bodily outward, and breaking the bolts. This peeling could hardly occur if the force of the explosion of the shell charge could waste itself in the empty region intervening between two plates mounted on the air-space system. The vertical armor of the Inflexible will weigh not less than 2585 tons with its backing, being over 500 tons in excess of that of any other ship in the navy, built or being built; but, besides this, she will be fitted with an iron-plated deck, weighing 967 tons, the total weight of her armor thus reaching not less than 3552 tons. She will be propelled by twin screws, and her engines will work up, it may be assumed, without much pressing, to 8000 indicated horse-power, when her speed will probably be a little in excess of fourteen knots. We do not speak here of measured mile runs, but of the service which may be reasonably expected from the ship if engaged in actual warfare. She is divided and subdivided to an enormous extent by water-tight bulkheads, and so far almost every conceivable precaution has been taken to make her secure against ram and torpedo. She will be fitted with a removable spur, which can be put on in time of war, while it will not endanger her consorts in time of peace; and she will be provided with light masts and spars apparently more for ornament than use.—*The Engineer.*

The King of Belgium will on the 26th of June personally open the Brussels exhibition of means and appliances for saving life,



CORNISH ENGINE, HULL WATER-WORKS.—VALVE GEAR AND PARALLEL MOTION.—*(See pp. 264–5 for description.)*

Scientific American Supplement.

No. 23.

FOR THE WEEK ENDING JUNE 3, 1876.

PUBLISHED WEEKLY,
AT THE
OFFICE OF THE SCIENTIFIC AMERICAN,
No. 37 Park Row, New-York.
MUNN & CO., Editors and Proprietors.
O. D. MUNN. A. E. BEACH.

The SCIENTIFIC AMERICAN SUPPLEMENT is uniform in size with the *Scientific American*. Terms of subscription for SUPPLEMENT, $5.00 a year, postage paid, to subscribers. Single copies, 10 cents. Sold by all newsdealers throughout the country.

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BRITISH COLONIAL EXHIBITS.

NEXT to that of the United States, the British display at the International Exhibition is, perhaps, the largest. The British Colonial exhibits are worthy of especial notice. Taken altogether the Provinces occupy a large space, and some of them are fitted up in elegant style.

JAMAICA.

Commencing where Great Britain and Ireland ends, the first of the British Provinces on the main aisle in the Main Exhibition Building, is Jamaica. The display made is one of much interest. Many classes of goods are represented, and afford a pleasant field of study.

There are nine exhibits of sugars, and over thirty brands of rums. The value of the rum exported from the Colony ranges from £240,000 to £290,000 annually.

Coffee, which is a staple product of importance in the Colony, is represented by numerous varieties, in glass jars. Then there are specimens of jams, candied goods, spices, etc. Besides these there are starches and other vegetable products.

Among the most interesting exhibits in the Jamaica Department are the essential oils and valuable woods. There is quite a list of the oils, and oft he woods there are fifty varieties. They are all nicely polished and properly labelled, so that the observer may examine them at leisure. Among the specimens are fiddle-wood, beautiful grained and adapted for fancy work; mahogany; Braziletto wood, for ornamenting cabinet work; mahoc, prettily variegated; lignum vitæ, Jamaica ebony, and numerous other specimens.

The collection of bark is also valuable, embracing quinine, bitter wood, jalap, senna, and many others used in preparing medical substances. The exhibit of fibres contains forty different varieties, and there are also many specimens of tanning substances, tobacco leaf, liquors, etc., making altogether 450 different classes of goods arranged in the Department.

NEW-ZEALAND.

New-Zealand is the next in order of the British colonies. A gilt pillar, over twenty feet in height, stands in the centre of this section, and represents the amount of gold exported from the country since 1862, being valued at over one hundred and fifty million dollars.

This section is rich in fine wools, grains, gums and varnishes, as also in flax. A number of large-sized photographs are arranged about the section to illustrate native life in New-Zealand. A mammoth piece of Rimu wood, about eight feet long and four wide, and highly polished, forms an attractive feature. Near it is a case containing muffs made of the pretty white feathers of the emu, and in a side case is a large mat manufactured of bran-new New-Zealand flax, and containing a number of tags from wild dogs, now extinct. Three specimens of Crania represent the Ethnological Department.

NEW SOUTH WALES.

New South Wales follows New-Zealand, and the display made by this country is especially rich and valuable in the department of mining and metallurgy. A huge pyramid of coal built of cubical blocks, is surrounded by numerous specimens of rocks and soils from the mesozoic and middle paleozoic period. A valuable collection of fossils from the marine beds below the coal measure, and of fossil flora from the upper coal measures, are exhibited here, and will be especially interesting to the student of natural history and geology. In the same section are a large number of tin ores, including lode tin, grain tin, and the refined metal, and then came a number of bones of animals found in the lower miocene formations.

The gold exported from New South Wales during the past eight years, is represented by a gilt pyramid, and the value is stated at $167,949,355. The section is also rich in varieties of maize, millet, tobacco, flour, preserved meats and fruits. There is also a large collection of native ferns pasted upon paper, and forming an interesting study. A panoramic view of Sydney harbor and suburbs is placed along one side of the section, while fine samples of silk and a number of cases containing cocoons are arranged near by. New South Wales also contributes over one hundred varieties of native hard woods, all finely polished and neatly arranged, and also presents exhibits of saddlery, wools, shawls, and dry goods.

In the sections allotted to Tasmania and South Australia, very little progress has been made, owing to the fact that the goods which were shipped last December are still at sea.

VICTORIA.

Victoria covers considerable space in the British section, and a large number of photographs give the visitor a fair idea of the appearance of the country, and the habits, etc. of the people. The exhibit embraces preserved meats, fine oils and wines, ancient implements, silks and cocoons, Myall pipes, *fac similes* of fruits, and there are forty samples of wools, furs, shawls, etc. The mining department contains *fac similes* of nuggets, also cases of magnetic iron, sands, and ores, sapphires and garnets in the rough, and a large lot of hides and patent-leather goods.

BERMUDA.

After Victoria comes Bermuda, and here, naturally, the visitor looks for arrowroot, coffee, etc., which are well represented. There are beautiful specimens of pomegranate, black mangrove and cedar woods, and a section of the Gru-gru palm. A large symmetrical model of the Bermuda Dry-dock attracts considerable attention, as well as a handsome and varied collection of corals, stalactites, and stratified coralline rock. One specimen in particular, a huge globular coral, is especially worthy of notice. Various samples of building stone and cases of shells complete the collection.

WEST INDIAN COLONIES.

The Bahamas, the next of the Colonial displays, though not large, is excellent. The exhibit includes cases of shells, samples of salts, sponges, preserved fruits, ropes made of Palientto leaf, and a number of ornamental shell-work goods.

Trinidad devotes most of its space to basket and wicker work, matting, gums, cocoa, woods and hemp.

British Guiana confines its display to seeds, bay rum, fibres of plantain, coffees and vegetable products, with a few jars containing reptiles of different species.

AFRICAN COLONIES.

The Gold Coast section is ornamented with leopard's hides and skins, and strange looking utensils. Here, too, are samples of gold dust, niger cloth, jewelry, coffee, palm oil, etc.

The space allotted to the Cape of Good Hope is one of the most interesting of the British display. It is enclosed in an octagonal area and decorated both within and without with the horns and tusks of wild animals, while skins of lions and tigers hang upon the outer walls. Forming a semicircle over the entrance two immense elephant tusks are placed, weighing 170 and 174 pounds respectively. A case of diamonds in the rough, and hundreds of ostrich feathers also attract much admiration, as well as models of a dry dock and of Table Bay, Cape Town.

Ostrich eggs are shown by the dozen, likewise shells, ornaments, etc. An ostrich incubator is shown in this section, which is worthy of particular notice. By this arrangement a gentleman at Cape Town last year succeeded in raising six hundred of the big birds. The young, when two days old, are as large as a full-grown chicken. From specimens exhibited it is evident that three Cape of Good Hope oysters would make a fair meal for one person.

The section contains a number of woods from the Alexander Crain forests, among which is a beautiful piece of ebony. Then there are contributions of aloes, tobacco, minerals, wines, barks, wools, and a Kaffir dress formerly worn by a native doctor to cure diseases, but it failed to cure himself, and he left for the land of the hereafter. The various goods used by the Kaffirs are original and peculiar, and give a good insight into the manners of the natives.

QUEENSLAND.

Queensland, the last of the British sections visited to-day, is one of the largest and most valuable of the colonial displays. It is neatly enclosed and artistically arranged, and presents many attractions. Hundreds of paintings and photographs illustrative of life and scenery in the country represented adorn the walls, while the collection of ores, soils, and woods is very full and interesting. During the past eight years over sixty-five tons of gold have been exported from Queensland, and the country is also rich in minerals, oils, silks and gums. Charts containing the different statistics of the colony are placed above the several exhibits, and contain much profitable information. A number of handsome agates and a case of native butterflies add pleasantly to the effect. Besides, there are many samples of grain, sugars, sandstones, and some forty or fifty varieties of marble.—*Philadelphia Evening Bulletin.*

THE WOMEN'S PAVILION EXHIBIT.

THE Women's Pavilion covers one acre of ground, and is situated on Belmont avenue, east of the Government Building. It is built in shape of a cross, with the spaces between the arms of the cross roofed over, thus forming four small pavilions in addition to the main hall. The exterior is colored pale drab, relieved with stripes and panels of chocolate color. There are three entrances—one on each of the sides of the building, except the north side. On either side of these entrances are panels colored in blue, with the sentence, "Let her own works praise her in the gates." It is in gilt letters, and in the English, German, Spanish, French, Italian, and Japanese languages. Above each of the doorways, in gilt letters, on a blue ground, is the inscription, "Women's Department."

An engraving of the Pavilion will be found in No. 8, page 113 of our SUPPLEMENT.

The interior of the building has been colored in pale blue, with flower-work of darker blue. The effect is at once simple and pleasing. The walls have been richly decorated with flags, the Brazilian standard occupying a conspicuous position over the east entrance. From the centre of the structure hangs a very handsome chandelier, colored in dark blue and gilt. Beneath this is a refreshing fountain, with iron basin, about which are placed geraniums and other richly-colored flowers.

The contents of this building are such a surprise to the ordinary visitor that he at once becomes interested by the unexpected novelty and the varied attractiveness of the articles which he sees about him. Beginning at the south entrance we see on one side the office of Mrs. E. D. Gillespie, President of the Women's Centennial Organization, and on the other side the office of the Women's Centennial Executive Committee.

On the partitions separating these rooms from the main hall hang photographs of various public institutions founded or managed by women. The south-eastern section of the building is occupied by mechanical inventions of women, and needle-work, of which there are some very beautiful specimens. The first case in this section, approaching from the south, is that containing embroidery done by women in the establishment of Horstmann Brothers & Co. of this city. The specimens consist chiefly of Masonic regalia, altar-cloths, etc., all in rich colors, beautifully blended. Near by, Mary S. Riley, of Louisville, Ky., makes one of the most interesting and wonderful exhibits in the entire collection. It consists of admirable portraits of individuals, taken either by embroidering in silk or by working in worsted. Notwithstanding the apparently insuperable difficulties in this process in the way of securing delicate shading with such cumbrous and unmanageable materials, the artist has succeeded in several instances in producing work in black and white, which at a little distance can not be distinguished from etching. The work in different colors is also wonderful, but is nothing to compare in fidelity and sharpness of outline with the work in black and white. By means of simply stitching black and white silk on a white ground, the artist has succeeded in producing admirable portraits of Hon. W. E. Gladstone and John Bright, and of James Bridgeford, of Louisville, Ky. She has wrought in worsted, pictures of Queen Victoria, Prince Albert, the Prince and Princess of Wales, and the Princess Royal of England, now Crown Princess of Germany. But the most ambitious and the most interesting piece in the collection is a picture in worsted work representing the "Battle of Langside; or, the Death of Douglas in Defence of Mary Queen of Scots." In the foreground is Douglas lying on the ground in his armor: with his charger near by, and his knights surrounding him. Queen Mary is bending over with a look of anxious solicitude, and a monk near by holds a cross to his (Douglas') lips. Above him spread the boughs of a large oak, and in the distance may be seen the smoke of battle. The success which the artist has achieved in blending colors and in shading is really wonderful. The deep green foliage of the trees, the rich velvet and silken garments of the knights and ladies, the bright trapping of the horses—even the deathly pallor and expression of agony on Douglas' face—all are brought out with almost as much clearness as if they had been painted.

Mrs. C. Hewitt Pfordt, of Albany, N. Y., exhibits embroidery on silk, in designs representing Masonic emblems on one side and an eagle with an American shield on the other; and near by the Union Benevolent Association of Philadelphia and the Employment Society of Providence, R. I., together with several individual exhibitors from Providence, display some very choice specimens of fine needlework. Fannie G. Brown, of East Greenwich, L. I., sends a large pin cushion in blue silk, with ears of wheat and flowers beautifully embroidered. Lina Fuldner, of Milwaukee, Wis., and Mrs. A. J. Davis, of Providence, R. I., respectively exhibit specimens of elaborately wrought worsted work and embroidery of monograms. Miss J. Whittemore, of Charleston, S. C., has a large picture of Washington at Trenton, in worsted work, and a lady, seventy-eight years old (the grand-daughter of Major Clapp, of the Revolutionary army), contributes a pair of curious looking worsted mittens knit by herself. They are in red, white and blue, and bear the inscription, "Uncle Sam's Mittens. 1776–1876, Centennial of Independence." Miss Julia Weiller contributes an amusing picture very well executed in worsted, called "Hide and Seek," and Mrs. E. J. States, of Boston, sends a large collection of embroidery, together with an instrument for stamping patterns on cloth for embroidery, said to have been found in the ruins of Sidon. It is made of hard wood, and the pattern stamped by it is a very pretty one. Mrs. S. E. Anthony, of Smyrna, Del., exhibits a handsome piece of worsted work in a variety of patterns, and Miss Susie Barton, of Prince George County, Maryland, contributes a well executed picture in tapestry. Amanda S. Ham, of Rochester, New-York, and Mrs. E. B. Shapleigh, of Philadelphia, exhibit some very curious and pretty rugs made of carpet rags. From the Women's Executive Committee of Wisconsin there are exhibited specimens of excellent needlework executed by the children of St. Rose's Orphan Asylum, Milwaukee. Miss Edith Beach, of West Hartford, Connecticut, has a creeping rug designed to amuse and instruct children. The groundwork is of black cloth with a central space in red, on which a monogram is worked. On the black ground are pictures of elephants, dogs, horses, etc., very faithfully executed, and in such number and variety that they could not fail of being a source of long-continued enjoyment for a child. Miss Melanie Heubel, of Philadelphia, exhibits a picture executed in embroidery, and Mrs. Mary Champneys, of Billerica, Massachusetts, sends some socks which she knit without the aid of glasses in this, her 100th year. Mrs. A. B. Thomas, of Farmington, Illinois, the Ladies' Depository of Philadelphia, Mrs. J. G. Dickerson, for the Women's Centennial Committees of Maine, and Mrs. E. Keyser, of Philadelphia, contribute a number of specimens of embroidery. Specimens of sewing-machine work done by Miss Ella Hayes and two sewing-machines are exhibited by the American Sewing-Machine Company. From the city of Worcester, Massachusetts, some handsome specimens of embroidery are exhibited. Among these is a beautiful fine screen of pale-green silk, embroidered in representation of the apple-blossom and narcissus. There is also some very fine lace-work by a lady eighty years of age. Mrs. W. G. Weld exhibits panels of yellow satin richly embroidered with butterflies and flowers. A number of ladies from Baltimore send some very artistic needlework, and the Sisters of the House of the Good Shepherd, Baltimore, exhibit a number of finely embroidered garments for children. There are also specimens of needlework and lacework from Frederick City, Mount Washington and Annapolis, Maryland; Boston, South Lancaster and New-Bedford, Mass.; Jersey City, N. J.; Saratoga Springs, N. Y.; Providence and Pawtucket, R. I.; Cincinnati, Ohio, and Benson, Vt. Lace manufactured in Belgium is exhibited in great variety of patterns by L. Noot, of Philadelphia, and Mrs. Emeline M. Shepherd sends some delicate embroidery on fine cambric. From England, the Misses Harding, of Islington Lodge, King's Lynn, Norfolk, send some very beautiful specimens of needlework. Fanny Harding exhibits a piece of tapestry in imitation of Flemish tapestry in the possession of the Marquis Townsend; Emily Harding, a head-piece for bed, in crewel and silk, with sunflowers upon blue serge; Caroline Harding, a piece of crewel and silk closely wrought and bearing an owl and tree; and Caroline and Emily Harding together, a handsome bedquilt. These are all, with one exception, from original designs, and are very handsome, both in design and execution. The Sisters of St. Joseph, at St. Augustine, Florida, and Levannah Eggleston, of Northfield, Vt., send some noticeable pieces of embroidery. Mrs. Parker, of Dundee, Scotland, sends a very handsome collection of Fayal lace shawls, handkerchiefs, collars, cravats, etc. The Khedive of Egypt contributes some very rich specimens of embroidery on silk and velvet, by women; and Miss Lucy Marian Hubbard, of Addington Manor, Winslow, England, exhibits some beautiful specimens of lace work, wrought by cottagers in Buckinghamshire, England. The mechanical inventions exhibited by women occupy a considerable space adjoining the display of needlework.

There is a very great variety of useful articles exhibited, including a combination desk, which, when folded, occupies only 18 inches, but when unfolded, seven feet; patent inkstands, a cover to protect horses from the sun, brackets to take the place of bed-slats, spring saddle, mosquito bar, smoothing-iron heated by gas, bedsteads containing drawers and secret compartments, prospective outline models, flower-stands, illuminated sign, patent darner for darning stockings, blanket-washer, frame for stretching and drying lace curtains, dusting-rack, aid to thread sewing-machine needles, charts for instructing persons how to fit themselves for cutting garments, combined travelling bag and chair, chest protector, night signals (now in use in the United States Navy), surgical appliances, artificial teeth, and other articles.

Above the eastern entrance a gallery has been erected, which has not yet been put to any use. It may be used either for exhibition purposes, or as a gallery for an orchestra. On either side of the stairway leading to this gallery is exhibited a fine collection of mosses preserved by Mrs. B. J. Luther, of

Providence, R. I. On the north side of the stairway there is also a fine collection of ferns and preserved flowers.

The northeastern section of the building is occupied by the needlework sent by the Queen and Royal Family of Great Britain, specimens of work in artificial flowers, articles made by Indian women, wire work, silk, woollen, and linen looms, with women at work at them, and a variety of miscellaneous articles. Anna E. Bickerton and E. Sahler, of Philadelphia, exhibit some very natural-looking wax flowers, and Mrs. L. Kampmann, of Philadelphia, has some very curious work in hair. Mrs. M. L. Ware, of Philadelphia, exhibits flowers in an excellent state of preservation, and Sallie M. Holcombe, of Philadelphia, sends the Lord's Prayer and a picture of Hyde Park, on the Hudson, beautifully executed in hair-work. One of the most interesting exhibits in this portion of the building is a collection of articles made by Indian women in the Indian Territory. It is exhibited by Margaret C. Richards, formerly of Wichita Agency, and comprises a model of a wigwam, mountain gig, such as is used by the Indians for conveying their squaws and papooses in mountainous regions; smoking-pouch, trunk covers, boa cases, and quivers of fur, etc. Some of the articles are very ingeniously and tastefully made.

Sarah E. Bonney, of Sterling, Mass., exhibits birds shot and stuffed by herself, and Mrs. John S. Palmer, of Providence, R. I., sends a cross made of the pith of the Japan rose beautifully executed and closely resembling marble.

Miss Charlotte Nyeland, of Denmark, exhibits some handsome pictures in spatter-work; the groundwork being dark gray, from which the figures in white stand out in clear relief. Toy furniture tastefully carved is exhibited by Mrs. W. W. Steck, of Woodbury, N. J., and artificial flowers in wax, paper, and shells are exhibited by T. Jeremias, Harriet F. Baily, Mrs. Thomas Weaver, Mrs. Springer, and Fannie C. Whittington, of Philadelphia. Specimens of work by Winnebago and Iowa Indian women, and photographs of Indian schools taught by women—the latter contributed by the Friends' Indian Aid Association of Philadelphia—are exhibited, together with some beautiful specimens of Florida moss, hats made of palmetto, with Florida grasses and flowers, wreaths of mosses, fine cones, grasses, etc.; bouquets of flowers made of fish-scales, and hat made of corn husks, exhibited by ladies of St. Augustine and Jacksonville, Fla.; and cap, cape, and muffs made of silk from milk-weed, exhibited by J. E. Merritt, of Brooklyn, and Miss Rebecca C. Orrend, of Kent County, Md.

Artificial flowers and birds made of worsted are exhibited by Mrs. Perrior, of Des Moines, Iowa, and Eloise B. Walcott sends hats and articles in straw manufactured in imitation of those made by the Saratoga Indians.

From Hartford, Conn., a number of handsome designs for lace, etchings, paintings on metal and porcelain, and covers for paper-boxes made by women at the Plimpton manufactory are exhibited. Mrs. P. V. Hathaway sends a very interesting collection of the flora of Stephenson County, Ill.; and Miss Jennie Watson, of Massillon, Ohio, exhibits a large collection of North-American mosses, some of which are very beautiful. In a large case in the southwestern corner of this section is an exhibit of crochet work and embroidery by the New-York Institution for the Blind. The Pennsylvania Home for Blind Women also contributes some highly interesting articles in wicker and worsted work made by the inmates. Artificial flowers, made by the lineal descendants of Thomas Jefferson, are exhibited in a prominent position, and on the opposite or western side of the section are exhibited the specimens of needlework sent by the Queen of England. In this collection are embroideries by the Princesses Alice and Helena, a handsome piece of embroidery in yellow, purple, and black, by the Princess Beatrice, and a napkin spun by Queen Victoria.

In this section there are also exhibits of hosiery from Lowell, Mass., braid from Hartford, Conn., and worsted shawls from New-York, all made by women. In the extreme northeastern section of the building are specimens of machinery operated by women, including a silk-weaving machine from Annie E. Taylor, of Taylor & Co., Philadelphia; a carpet-loom from John Bromley & Sons, Philadelphia; a linen-loom from George Crompton, Worcester, Mass.; and a ribbon-spinning machine from Werner, Itchner & Co., of Philadelphia. These machines are all exhibited in motion, manufacturing goods, with the women at work at them. They are run by a ten-horse-power Baxter engine, which is placed in a small engine-house north of the building. This engine is now in charge of a man, but it is contemplated to put it in charge of a woman, who is recommended to the Women's Committee as being a thoroughly competent engineer.

The northern section of the building is divided up into six alcoves, in which are the fine art exhibits. Near the southern line of this section are exhibited the etchings of the Queen of England. These are mostly copies of animals after Landseer, with a few original sketches. West and south of these is the exhibit of the Royal School of Art needlework of England, comprising some extremely beautiful specimens of embroidery. In this collection are exhibited two beautiful curtains embroidered by the Princess Louise, Marchioness of Lorne. Further to the north is a handsome screen painted in lilies and violets on pale lilac and white silk by Mrs. Alan Smith, of Baltimore, Md. In the eastern section of the Fine Art Department are exhibited a number of paintings in oil by American and foreign artists. The wall space dividing the eastern and western sections is reserved for the exhibit of statuary to be made by Miss Hosmer, the well-known American artist. This statuary, together with a number of other articles from Italy, arrived in the United States ship Suppiy, but have not yet been unpacked. In front of the space now hangs a very large banner presented by the women of New-York. It is of white silk, richly embroidered, and bearing the arms of the city of New-York.

The western alcoves are occupied by a number of paintings, etchings, engravings, statues, etc. Susan Hayes Ward and Mrs. E. J. Sterling, of New-York, exhibit some very handsome tiles of original design, and there are a number of pretty water-colors by English artists. There are medallions of Charles Sumner and Joshua, by Miss M. J. Foley, of Rome, and statues representing "Eve" and "Cinderella" by Miss Blanche Nevin, of this city. Eliza Greatorex, of New-York, sends some very interesting sketches of Ober-Ammergau, in Germany, the home of the Passion Play, and near by is exhibited the costume of the Pharisee as worn in one of those plays 150 years ago. Mrs. T. G. Wormley, of Columbus, O., exhibits steel engravings executed by herself, and illustrating Dr. Wormley's "Microchemistry of Poisons."

Two handsome ebony vases decorated in pink flowers are exhibited by Miss Rosnholdt, of Copenhagen, Denmark, and some very handsome decorated china is sent by Harriet Ashburner, of Philadelphia; Mrs. O. M. Hayes, of Newark, N. J.; and S. H. Foster, of Portsmouth, N. H. Some of this china is very pretty, both in pattern and coloring.

A screen, covered with varied patterns in strong colors, is exhibited by Mrs. M. E. Parker, of Dundee, Scotland. There are also some very handsome etchings, paintings, and designs for carpets, wall-paper, oil-cloth, tiles, calicoes, lace, china, etc., from pupils of the Industrial Art Schools of Boston and Lowell, Mass., the Women's Art Department of the Cooper Union, New-York City, and the School of Design, Cincinnati. Some of these are really very fine, and worthy of careful study.

The Women's Centennial Executive Committee of Wisconsin sends a carved ebony cabinet, with exquisite water views painted on the doors, and a piece of embroidery. The northwestern section of the building is chiefly occupied with furniture carved by the pupils of the School of Design, Cincinnati, O. All of the furniture has not yet arrived, but enough is in place to give the visitor some idea of what the whole will be when finished. Some of the carved work on the bedsteads, cabinets, etc., is really exquisite in design and execution.

One of the most beautiful specimens is a large bed of walnut, inlaid with ebony and carved in imitation of poppies, morning-glories, etc., by two girls aged respectively sixteen and seventeen years of age. There is also a rosewood piano and an organ, both richly carved. In addition to the carving there are exhibited from this school paintings on slate and tiles, decorated china, a bust and paintings in oil—all of a high order of merit. Near by are paintings by ladies of Vermont, decorated china by ladies of Lowell, Mass.; beautiful specimens of carving in Sorrento wood by Miss M. M. Brainerd, of Worcester, Mass.; a carved and painted screen by Miss Adams, of Baltimore, and china and gas shades decorated by ladies of Boston and Cambridge, Mass.

The Women's Medical College of Philadelphia exhibits pharmaceutical preparations in the southwestern section of the building, but the remainder of this section is entirely occupied with the exhibits of foreign countries.

Japan occupies the southern portion of the section, and makes a very beautiful display of painted work. One of the most striking of the exhibits is a large six-panelled screen, having a framework of ebony, ornamented with gilt and brass plates. The back of the screen is covered with a plain gold pattern, but the front is of very beautiful design, the ground being of yellow silk, on which are worked a variety of ladies' fans. On these are depicted Japanese mechanics, tradesmen, farmers, jugglers, etc., at work. The figures themselves are of paper, but their clothing, with all its variety of coloring, ornament and detail, is made of silk, raised from the surface of the screens.

There are also a number of pictures made of silk and worsted needlework, in bas relief to the canvas. The coloring of all these pictures is very rich and the varied tints are arranged with great harmony. Among the other exhibits are cigar cases, artificial flowers, pincushions, satchels, and figures of wool and silk, boxes of colors, and instruments used in this delicate work, and a cabinet containing screens and ottomans, embroidered in silk. The exhibit, as a whole, is exceedingly curious and interesting, not only on account of the beauty and quaintness of the articles themselves, but also because it gives us a vivid glimpse of the domestic life of the Japanese nation.

Norway exhibits nine samples of delicate needlework in frames, with embroidery representing flowers, animals, birds, etc. There is also a model of a room completely furnished. The curtains, carpets, bed-covers, etc., are all beautiful needlework. In addition to this there are exhibited specimens of lace, embroidery, napkins, pressed flowers, embroidered cushions, and a screen in wool and silk representing three children fishing.

Canada exhibits a case containing three handsome silk dresses, pictures in worsted work, representing "The Last Supper," and a vase of flowers, a screen and chair worked in wool, two albums of Canadian wild-flowers, models of the Church and Chapel of Notre Dame, Montreal, and the Mother House of the Sisters of Notre Dame, a cabinet containing samples of elegant knit-work and embroidery, and models of the Orphanage at Joliette, Canada. St. Alexis' Orphan Asylum, Montreal, the Monastery of the Good Shepherd, Montreal, the Convent of the Good Shepherd, Quebec, the Hotel Dieu, Montreal, the Hospitale Generale, Quebec, and a photograph of the Governor-General of Canada, encircled in a beautiful wreath of carved wood.

There are also specimens of straw-work, silk flower-work, crochet, lace, anti-macassar, and crétonne work, a model of St. John's Insane Asylum, near Montreal, and photographs of public institutions conducted by women, wax-flowers, a portrait of Mary Queen of Scots in worsted, a collective exhibit of straw-hats, models of convents, artificial flowers, needle-worked pictures, photographs, paintings of autumn leaves, and some richly embroidered clerical raiment, a picture in wool of "The Last Supper," also a small oil-painting of "The Angel and the Hermit," and a large mirror, encircled by a handsome frame of carved leather in fruit, flowers, and leaves.

The Netherlands exhibit quilts, laces, feather-work, a doll dressed as a peasant woman of Breda; cushions, etc., contributed by the Women's Union of Breda.

Brazil sends embroidered table-covers, wax-flowers, a model in cork of a castle, wreath of flowers made of leather, a cabinet of gold-lace work made by the inmates of the different orphan asylums in Brazil, and a very pretty little pincushion made of shells and silk, needlework by the Viscomtess de Itamaraty, cushions beautifully worked in silk and wool by the pupils of the Orphan College of St. Theresa and the College of the Imperial Society for the Love of Instruction, beautiful specimens of lace-work, scarfs, children's socks, and artificial flowers made of leather and feathers.

Sweden exhibits towels, filagree jewelry, lace, carving, Engdahl's method of writing, tapestry, crétonne work, artificial flowers, etchings, lace-making apparatus, embroidery, and a life-like group of Swedish peasants comprising three figures, in carved wood, painted and clothed in the national costume. Some articles have also arrived from France, but have not yet been unpacked.—*Public Ledger.*

INTERNATIONAL TRIAL OF MOWERS AND REAPERS.

THE following are the values to be given to the points of mowing and reaping machines at the International field trial to be held in Bucks Co., Pa., during June and July next, near Schenck and Eddington Stations, Phila. and Trenton R. R. The points are arranged under five heads, grouped into three divisions, those under each division to be first determined by a separate sub-committee of experts, then submitted to the full committee, and finally reported to the International Jury. Total number of points, 29. Total value of points, 1000.

Division A, construction and durability:

CONSTRUCTION.

1. General harmony of parts	85
2. Adaptation of parts	80
3. Mechanical construction of parts	100
4. Simplicity of construction	110
	375

DURABILITY.

1. Materials and strength of parts	80
2. Combination of parts	45
3. Provision for compensating wear	25
4. Facility with which parts broken may be replaced	25
	175

Division B, work; and safety and ease of management:

WORK.

1. Quality of work	125
2. Variety of work	55
3. Adaptation for work	35
4. Speed—fast or slow	10
5. Width of cut	5
6. Freedom from noise	3
	233

SAFETY AND EASE OF MANAGEMENT.

1. Safety to driver	40
2. Safety to horses	15
3. Position of driver's seat, foot rest and levers	25
4. Facilities for backing and turning corners	20
5. Facility for regulating height of cut	35
6. Ease of transfer	10
7. Accessibility to parts	30
	175

Division C, draft:

DRAFT.

1. Power required to draw machine, out of gear	5
2. Power required to draw machine, in gear	5
3. Actual power required while cutting	120
4. Proportion of weight made available to driving knife	10
5. Extreme vibration of dynamometer needle while cutting	25
6. Irregular draft	30
7. Side draft	20
8. Weight on horses' neck while cutting	10
	225

The draft as indicated by a self-registering dynamometer, having the value 120 in the scale of points, will be expressed in numbers of that scale, and not merely by the number of traction pounds, as is usually done.

To convert these pounds into points of the schedule, the machine having the lightest draft of all those of its classes when cutting will be rated at the full number—120 representing its value on the scale adopted; other machines to range below it according as their draft is greater. Their true position in the scale under this head will then be ascertained by inverse proportion. Thus, suppose the number of traction-pounds of the machine of the lightest recorded draft 94 lbs., and of two other machines 130 and 190 lbs., respectively; then on the scale, the machine of lightest draft would stand 120; the standing of the second machine by the proportion 130 : 94 : : 120 to the number sought, 87. For the third machine the proportion would be 190 : 94 : : 120 to the number sought, or 59. The numbers 120, 87, and 59 representing on the scale of points the traction pounds, 94, 130, and 190, recorded by the dynamometer.

FRUIT SYRUPS.

By A. F. W. NEYNABER.

As the fruit season is approaching, I would draw the attention of pharmaceutists to the chance they more or less have to prepare fruit syrups themselves directly from the fruit.

The two important points in making fruit syrups are: The fermentation of the fruit, and the boiling of the juice and sugar to syrup. Fermentation is necessary, and yet many pharmaceutists, otherwise highly educated in their business, have overlooked this important fact.

STRAWBERRY.

Use strawberries of a good flavor; do not forget that if the berries possess no flavor, you cannot expect to obtain a syrup of fine flavor. Avoid, also, rotten berries, because, unless you do, you may be sure to find as flavor the smell of the rotten berries in your syrup. Mash the fruit in a barrel or other suitable vessel by means of a pounder, and leave the pulp for twelve or twenty-four hours at a temperature between 70° and 80°, stir occasionally, press, set the juice aside for one night, add for every pound avoirdupois of juice one ounce avoirdupois of Cologne spirit or deodorized alcohol, mix, set aside for another night, and filter through paper.

For one pound of the filtered juice take one and a half pound of A sugar and heat to the boiling point, taking care to remove from the fire or turn off the steam as soon as the mixture begins to boil, remove the scum and bottle in perfectly clean bottles, rinsed with a little Cologne spirit.

Here I cannot help drawing attention to one of the worst nuisances in a drug store; that is, to taste the syrup by putting the bottle to the lips. The best syrup will spoil if not put into a clean, dry bottle, or into a washed bottle rinsed with Cologne spirit, and kept from being touched with foreign substances; but if the syrup is brought in contact with the saliva on the tongue and lips, it will surely spoil. If you wish to taste a syrup, pour a little of it into a spoon or on your hand, and then carry it to the mouth. We find stores where the windows are kept polished and the outside of bottles is clean: but the true cleanliness in handling the preparations and utensils is not to be found; the look into the inside of some of the shining marble syrup apparatus is utterly disgusting. Of course such are exceptions only!

PINEAPPLE.

Use pineapples of good flavor, cut or chop them up, and set aside for twenty-four to thirty six hours, press and proceed as directed for strawberry.

RASPBERRY.

Select berries of fine flavor, and proceed in the manner directed for strawberry.

These fruit syrups will have a fine flavor, and will be strong enough to be mixed with three to five parts of simple syrup for soda water.—*Druggists' Circular.*

INDELIBLE INK FOR RUBBER STAMPS.

AN excellent marking ink that dries rapidly and is free from grease may be cheaply prepared, by dissolving

Crystallized aniline black	½ ounce.
in pure alcohol	15 ounces.
And adding concentrated glycerine	15 "

to the solution. This liquid is poured upon the cushion and rubbed with a brush.

SHOW-CARD INK.

Pure asphaltum	16 ounces.
Venice turpentine	18 "
Lampblack	4 "
Spirit of turpentine	2 quarts.

Dissolve and mix thoroughly.

THE INTERNATIONAL EXHIBITION OF 1876.—SITE OF THE GRAND OPENING CEREMONIES BETWEEN THE MAIN BUILDING AND MEMORIAL HALL.

THE OPENING CEREMONIES OF THE EXHIBITION.

IN our last number of the SUPPLEMENT we gave a general description of the interesting ceremonies of May 10th, incident to the grand opening. In the present number we present an engraving of the place itself, namely, the space between the north front of the Main Exhibition building and the south front of Memorial Hall or Art Gallery. For this picture we are indebted to *Frank Leslie's Illustrated Newspaper*.

The view is towards the east, taken in the northern side of the Main Building, from a point a little west of its centre to its eastern end, more than two-thirds of the southern side of the Art Gallery, and the vast sea of humanity stretching from building to building, and along the Avenue of the Republic for more than 938 feet (half the length of the Main Building). In the distance is seen rising the northeastern tower of this structure. Suspended along the side of the latter are the flags and streamers of the forty-one nations represented by exhibits within the building. On the left, and immediately in front of the Art Gallery, is a tier-like arrangement of seats, nearly 350 feet in length, upon which were seated the Governor, State Officers, Supreme Court and Legislature of Pennsylvania; Governors of the States and their Staffs; the Members of the House of Representatives; the President of the United States; the United States Senate; Diplomatic Corps; United States Centennial Commission; Board of Finance; Women's Executive Committee; Foreign Commissioners and the Exhibition Boards and Bureaux; Foreign Consuls; Mayor, Councils and Departments of Philadelphia; Mayors of Cities; State Centennial Boards; Judges of Awards, and other dignitaries.

On the sides of the broad granite steps, ascending to the terrace of the Art Gallery, are seen, on immense pedestals of granite, two colossal groups in bronze, representing Pegasus in different attitudes, each held in check by a female figure, draped, and standing by its side. The figures are modelled in the strictly classic Greek style, and were purchased at the Vienna Exposition by a Philadelphia gentleman, who presented them to the Park Commissioners. They formerly were a portion of the ornaments of the Vienna Academy of Music.

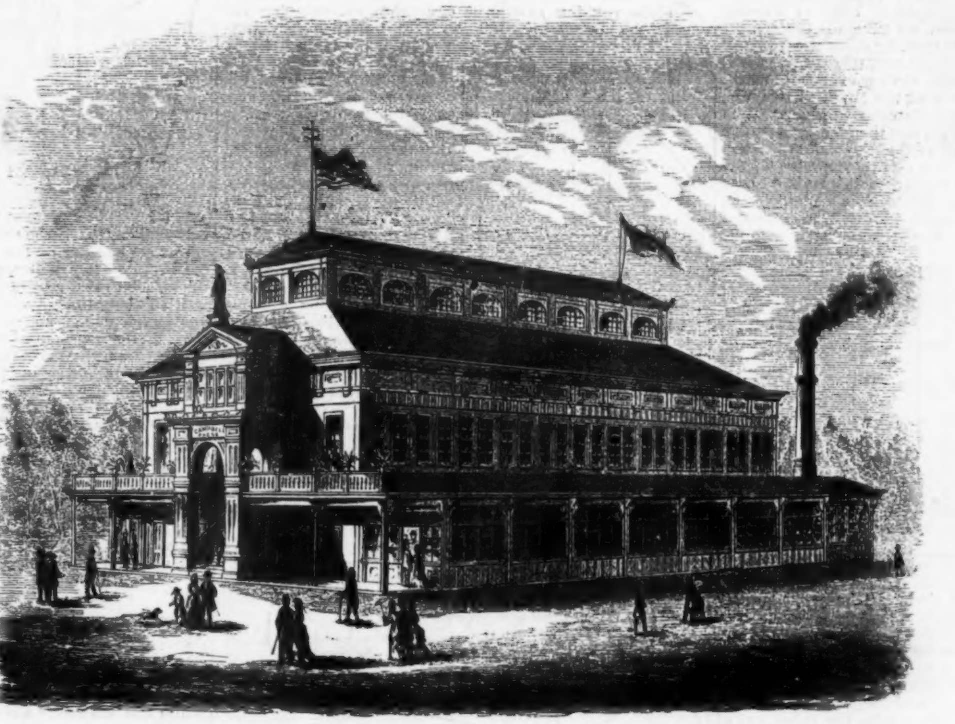
In the foreground, on the right, and immediately in front of the northern entrance to the Main Building, is the platform on which was stationed the grand orchestra of 150 members, and the grand chorus of 1100 singers.

EXHIBITS OF PRINTING MACHINERY.

THE development of the art of printing during the past century—"the art preservative of all arts"—is strikingly shown by the vast extent, variety, and wonderful capabilities of the printing appliances presented to view in the Exhibition. A single establishment, that of the Campbell Printing Press Company, has erected on the grounds a large and elegant building, shown in our engraving, in which all the operations connected with printing, and the production of printed matter, put up in completed form for public sale, are exhibited.

The building is 124 by 88 feet in extent, and is equipped as a complete newspaper office, with editorial, composing, and press-rooms, in the latter of which one of Campbell's rotary printing and folding machines is used to print an edition of the Philadelphia *Evening Herald*. This press prints from the end, and delivers the sheets either folded or flat. Its capacity in the former way is at the rate of 2000 per hour, while delivering the papers flat its speed is 2500 per hour. The forms are stereotyped by Campbell's process in a shorter time, it is said, than has been previously done. In the same building is a job office containing ten cylinder presses, one of which exhibits the heliotype process. Then there are six job presses, all in operation. The other rooms are divided into business offices, waiting and reception rooms for members of the press, correspondents, etc., together with a telegraph and post-office.

A very attractive feature of the exhibit is the original printing office of Isaiah Thomas, built in Boston in 1770. It is complete, including the press upon which the first copies of the Declaration of Independence were printed east of New York (from the Antiquarian Society of Worcester), the imposing stone (from the Worcester *Spy*), two cases, one stand, two chases, and two composing sticks (from Tyler & Sugrave, Boston). Many anecdotes and more than one romance are connected with the history of this old office, which will probably be rehearsed by editors and printers who visit it. Taken as a whole, the exhibit of the Campbell Press Company makes one of the largest and most interesting individual displays on the grounds.



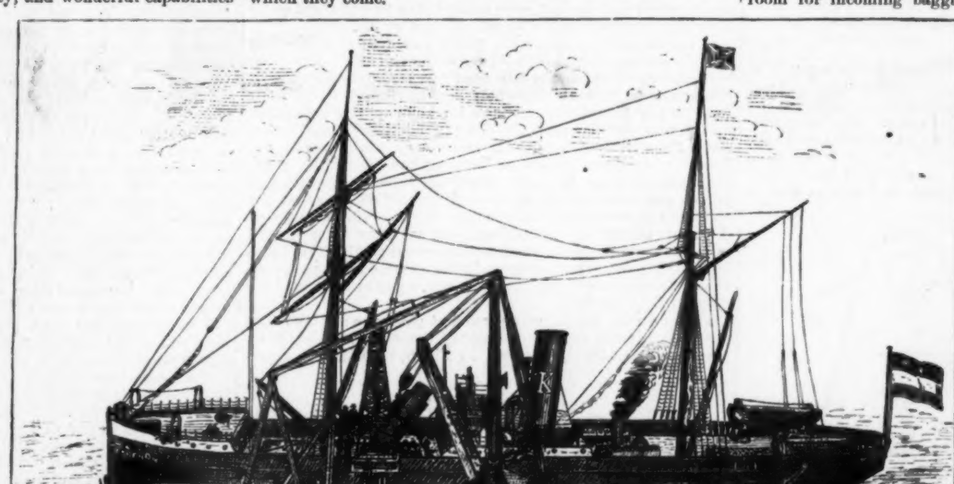
THE CAMPBELL PRINTING PRESS COMPANY'S EXHIBITION BUILDING.

EXHIBITS FROM THE KRUPP WORKS, ESSEN, PRUSSIA.

AMONG the Centennial exhibits, perhaps the foremost of individual displays are those of Frederick Krupp, whose great works at Essen, Prussia, for the production of large manufactures in iron and steel, especially implements of warfare, are so well known. We give a pen-and-ink sketch of the process of unloading at Philadelphia the monster cannon sent over from the above establishment. The large steamer Essen was almost exclusively laden with exhibits from Krupp's manufactory.

As the drawing shows, over the hatchway a derrick was erected, by which the monster was hoisted by two powerful windlasses, assisted by the 60-ton crane of W. C. Allison & Sons. When lifted clear, heavy angle steel rails were placed underneath, the derrick removed, and the gun rolled on a special gun-truck belonging to the Pennsylvania Railroad up to the Exhibition grounds.

Preliminary to a more extended notice of these exhibits, which we shall give hereafter, it may be interesting to mention a few particulars of the remarkable establishment from which they come.



UNLOADING OF THE GREAT KRUPP GUN AT PHILADEDPHIA.

The grounds belonging to the Krupp works at Essen embrace 1000 acres. The works are connected with the main Rhenish railway lines, and contain more than thirty miles of rail tracks. About 12,000 men are employed, besides 5000 men in the mines and smelting works, and others in other departments, making a total of about 20,000. Krupp has built for his officers and men good dwelling-houses and hospitals. A sick, burial, and pension fund had an income in 1873 of $80,000, and the expenditures amounted to about $60,000. Another fund secures free medical attendance upon an annual payment of 75 cents.

The works at Essen in 1874 included 1100 smelting and other furnaces; 275 coke ovens; 264 smith's forges; 300 steam-boilers; 71 steam-hammers, including a monster hammer similar to Nasmyth's; 286 steam-engines, with an aggregate of 10,000 horse-power; 1056 machine tools; a chemical laboratory, and photographic, lithographic, and printing and bookbinding establishments. A fire brigade of 70 acts also as a police force, besides 166 watchmen.

The consumption of coal was 500,000 tons a year; coke, 125,000 tons; gas, 155,000,000 cubic feet, for 16,500 burners; 125,000 tons or more of cast steel are produced yearly. The articles manufactured include guns, carriages, shot, boiler-plates, rolls, spring steel, machinery, axles, wheels, rails, and springs for railways and mines, and shafts for steamers.

PORTUGAL AT THE EXHIBITION.

PORTUGAL, in this Exhibition, has paid special attention to agriculture and industry. In the former department, there are 2,304 exhibitors, of which number over 1000 exhibit wines and cork. Portugal has already in America a very extensive market for cork, and a medium one for the black woollen cloths manufactured in the province of Alemtejo. Portugal exhibits an extensive collection of soaps, oils, etc., in order to display in the most satisfactory manner to the United States her different resources, by means of which the commercial relations between the two countries may be developed.

NEW DEPOT, PENNSYLVANIA RAILROAD, PHILADELPHIA.

THE new depot at the intersection of Thirty-second and Market streets is now finished. The building is two stories in height, with a total length of 185 feet and a width of 100 feet. It is located on the line of Thirty-second street, and is passed by both Market street and Lancaster avenue. On every side except the north there will extend around the building a porch 12 feet in width. On the north side this porch will be 50 feet wide. The first floor consists of the general waiting-room, 80 by 150 feet; the ladies' waiting-room, 40 by 100 feet; the restaurant, 40 by 84 feet; the ticket-office, news stand, telegraph office, Pullman Car Company's office, &c.

On the second floor are the offices for the superintendent, general agent, rooms for the conductors, train agents, receivers, &c., and immediately over the restaurant the kitchen will be situated.

Fifty feet northeast of the building is a room for the outgoing baggage, 40 by 50 feet, and opposite it, to the west, a room for incoming baggage, 25 by 100 feet. The roadbed between Thirty-first and Thirty-second streets contains twelve tracks. Of these, six near the middle of the roadbed will be used as tracks on which the cars are to stand while being washed. On the west side of these there are three tracks for incoming trains, covered by a shed 70 feet wide and 800 feet long. Three tracks on the east are arranged for outgoing trains in a similar manner. A short distance north of the depot these twelve tracks converge into three, which run north as far as Callowhill street bridge, where they will curve to the west, and near Thirty-second street and Haverford road they converge into two tracks. At Thirty-sixth street the New-York trains curve off to the north, while the western trains continue straight on.

CENTENNIAL ITEM.

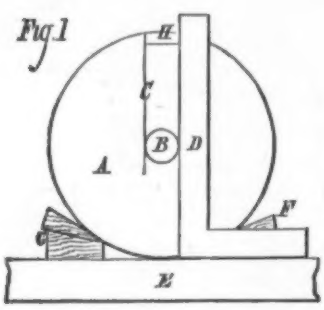
THE United States have 1,030 individual exhibits—considerably more than all the allotted spaces among all the foreign nations together. England has but 92 exhibits, Canada 198, France 98, Germany 96, Sweden 52, Belgium 28, Brazil 24, Norway 13, Italy 11, Netherlands 10, Argentine Republic 7, and Switzerland a modest 2. This excess of goods on exhibition would, of course, put the United States in a formidable position as regards foreign nations; but it is not from such a point that the United States takes her stand. It is on the quality—the superior quality of her goods on which she prizes herself—much more than on the quantity. The United States most excel in stationary engines, locomotives, machine tools, printing presses, sewing-machines, pumps, piping, tubing, and fire engines. There are thirteen locomotives exhibited, of all sizes, from the lightest to one of those that will drag a train of loaded cars over the Allegheny Mountains.

TO PLACE TWO CRANKS UPON A SHAFT SO THAT ONE SHALL STAND AT A RIGHT ANGLE TO THE OTHER.

By JOSHUA ROSE.

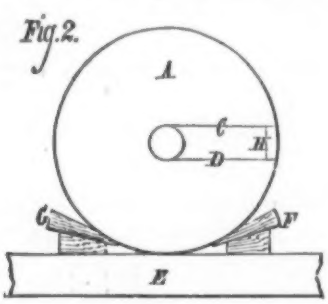
IT is obvious that the keyways in both the crank and the shaft must be cut accurately in their proper positions, because it is a tedious operation to file out the sides of the keyways when the cranks are placed upon the shaft. To mark the keyways in the absence of any tools or appliances specially designed for the purpose we proceed as follows: Placing the shaft upon a marking-off table, we plug up the centres upon which the shaft has been turned, by driving a piece of lead in them, leaving the surface level with those of the shaft; and then from the perimeter of the shaft we carefully mark, upon the lead plugs, the centres of the shaft. From this centre we describe a circle whose diameter will be equal to the required widths of the keyway, and then taking a square we place its stock upon the face of the marking-table, and bringing the edge of the blade even with the edge of the circle, we mark a perpendicular line upwards from the circle to the perimeter of the shaft, and then draw a similar line on the other side of the circle, as shown in Fig. 1, in which A

Fig. 1



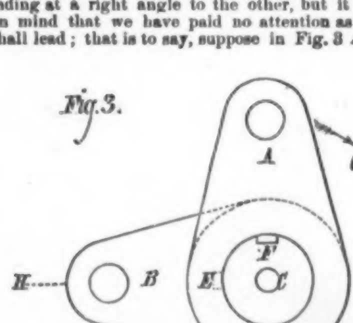
represents the shaft and B the circle, C the perpendicular line struck on one side of the circle, and D the square placed upon the marking-table E, in position to mark the line on the other side of the circle, F and G being wedges to keep the shaft A from moving its position upon the table. We next mark with a scribing-block or surface gage, the depth of the keyway as denoted by the line H, and the marking at that end of the shaft is completed. Passing to the other end of the shaft we find the centre of the shaft, and describe around it a circle equal in diameter to the required width of keyway, and from the edges of the circle to the perimeter of the shaft draw two lines with a scribing-block, as shown in Fig. 2, A

Fig. 2.



representing the shaft, B the circle, C and D the breadth of the keyway, E the marking-off table, F and G the wedges, and H the depth of the keyway, which must, in this case, be marked with a square resting on the table. We have now marked off on the end faces of the shaft a keyway at each end, one standing at a right angle to the other, but it must be borne in mind that we have paid no attention as to which crank shall lead; that is to say, suppose in Fig. 3 A and B

Fig. 3.



represent cranks placed upon the shaft C, and running in the direction of the arrow D, it is evident that the crank B leads in the direction in which the engine is to run, and hence the keyway E stands in advance of the keyway F, in Fig. 3; and therefore, as shown in Fig. 3, the right-hand crank leads. To have made the left-hand crank lead, when the engine runs in the direction of the arrow D, we should, supposing the keyway F to be already cut, have to cut the keyway E on the directly opposite side of the shaft; or, what is the same thing, supposing the keyway E to be already cut, the keyway F would require to be cut on the diametrically opposite side of the shaft. It is obvious that if the engine ran in the direction of the arrow G, the left-hand crank would lead, supposing in each case the cylinders to stand at H. Here it may be necessary to explain the manner of determining which is the right and which the left-hand crank. Suppose then that Fig. 3 represents a locomotive crank, the cylinders being at H, then as the engineer stands in the cab and faces his engine, A will be the left and B the right hand crank. It is usual in locomotives to make the left-hand crank lead when the engine is running forward, the practical difference being, that if the workman were by mistake to make the right crank lead, the engine would run forward when the reversing lever was placed to run backward, and *vice versa*. It makes no difference whether the shaft can be turned end for end or not: if the right or left crank is required to lead when the crank is required to revolve in a given direction the keyways in the shaft must be marked off in the relative positions on the shaft necessary to obtain that result.

To proceed. We have now to carry the lines of the keyways along the circumference of the shaft, and this we accomplish as follows: If the ends of the shaft are flat, or square, as it is commonly termed, we may carry the lines along by placing a square with the stock against the end face of the shaft, and the blade running along the circumference, bringing the edge of the blade exactly level with the lines at the perimeter. If, however, the end of the shaft is rounding, we may mark the keyway Fig. 1 as shown in Fig. 4, in which A represents the shaft with the keyway marked on the end, and B represents an angular piece of metal made true and straight (of any required length), so that when placed upon the circumference of a turned or straight shaft its edges will stand true and parallel with the length of the shaft; as shown in Fig. 4, the angle-piece is placed in position to mark off the side C of the keyway, by drawing with a scriber a line along the edge E of the angle-piece B.

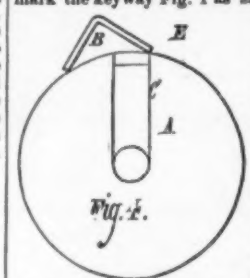
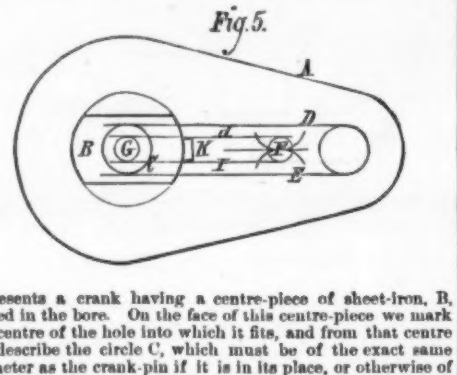


Fig. 4.

The keyway marked parallel with the face of the marking-table, as shown in Fig. 2, may be carried round on the circumference with the scribing-block at the same time that the lines C and D in that figure are marked.

To mark off the keyways in the cranks, we place a centre-piece in the bore of the crank, as shown in Fig. 5, in which A

Fig. 5.

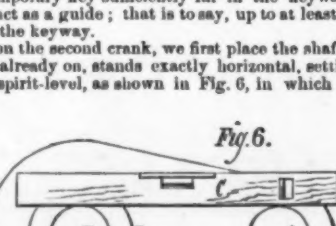


represents a crank having a centre-piece of sheet-iron, B, placed in the bore. On the face of this centre-piece we mark the centre of the hole into which it fits, and from that centre we describe the circle C, which must be of the exact same diameter as the crank-pin if it is in its place, or otherwise of the crank-pin hole. We then draw the lines D and E, using as a guide a straight-edge placed one end upon the crank-pin journal, or even with the edge of the crank-pin hole, as the case may be, and the other end (of the same edge of the straight-edge) exactly even with the circumference of the circle C. From D and E we find the centre of the circle F, which must be central between D and E, and whose diameter must be exactly equal to the required width of keyway; and we then mark the circle G, describing it from the centre of the hole, and therefore of the circle C. By drawing the lines H and I, which must be even with the circumference of the circles F and G, using a straight-edge as a guide, we shall obtain the correct position for the keyway K, and the whole of the keyways may be cut, care being taken to cut them quite true with the lines, and of an exact equal width.

In putting the cranks on we proceed as follows: We first provide a temporary key, a close fit on the sides, but clear top and bottom, so that it will bind just easily on the sides of the keyways in both the shaft and the crank. The shaft must be placed and wedged with its keyway downwards, so that in putting the crank on, the pin end may hang downwards, which will render it more easy both to put on, handle, and adjust. As soon as the shaft has entered the crank, say a quarter of an inch, we must insert the temporary key (which may have its end edges well tapered off to assist the operation of entering it) sufficiently far into the keyway of the shaft that it will not fall out, and we may then proceed to put the crank on the shaft to the necessary distance, keeping the temporary key sufficiently far in the keyway to enable it to act as a guide; that is to say, up to at least half the length of the keyway.

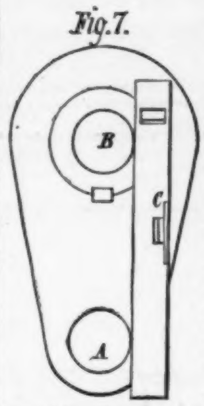
To put on the second crank, we first place the shaft so that the crank already on, stands exactly horizontal, setting it by placing a spirit-level, as shown in Fig. 6, in which A represents

Fig. 6.



sents either the crank-pin journal or the crank-pin hole in the crank, and B a circle struck on the end face of the shaft and from its centre, the diameter of the circle B being exactly the same as that of A. If then we so adjust the position of the crank that a spirit-level applied to the exact circumferences of the circles A and B stands level, the crank will stand level, and we have only to put the second crank on with its centre-line standing perpendicular, and the two cranks will be at a right angle one to the other. We now proceed to put on the second crank, pursuing the same method employed in putting on the first one, save that the temporary key need not be inserted so far into the keyway, because, if the keyways have been cut the least out of true, it will make a great difference at the crank-pin, because of the latter's increased distance from the centre of the crank-shaft. As soon as the second crank is placed to its position on the shaft we must ascertain if it stands vertical, which we may do by applying the spirit-level as shown in Fig. 7, bringing its edges exactly fair with the edges of the circles A and B, and moving the

Fig. 7.



crank until the bubble of the level stands true, and taking out the temporary key if it is necessary to adjust the crank at all.

If, however, the crank is to be forced on by hydraulic pressure, this latter adjustment should be made when the crank is just sufficiently far on the crank-shaft to enable it to bind enough to well support its own weight, to facilitate which the end of the shaft is sometimes slightly tapered for a very short distance—a practice, however, which is not to be commended, and which is usually rendered unnecessary, by reason of there being attachments fitted to the hydraulic presses which of themselves adjust the position of the cranks, and ensure their being at a right angle one to the other.

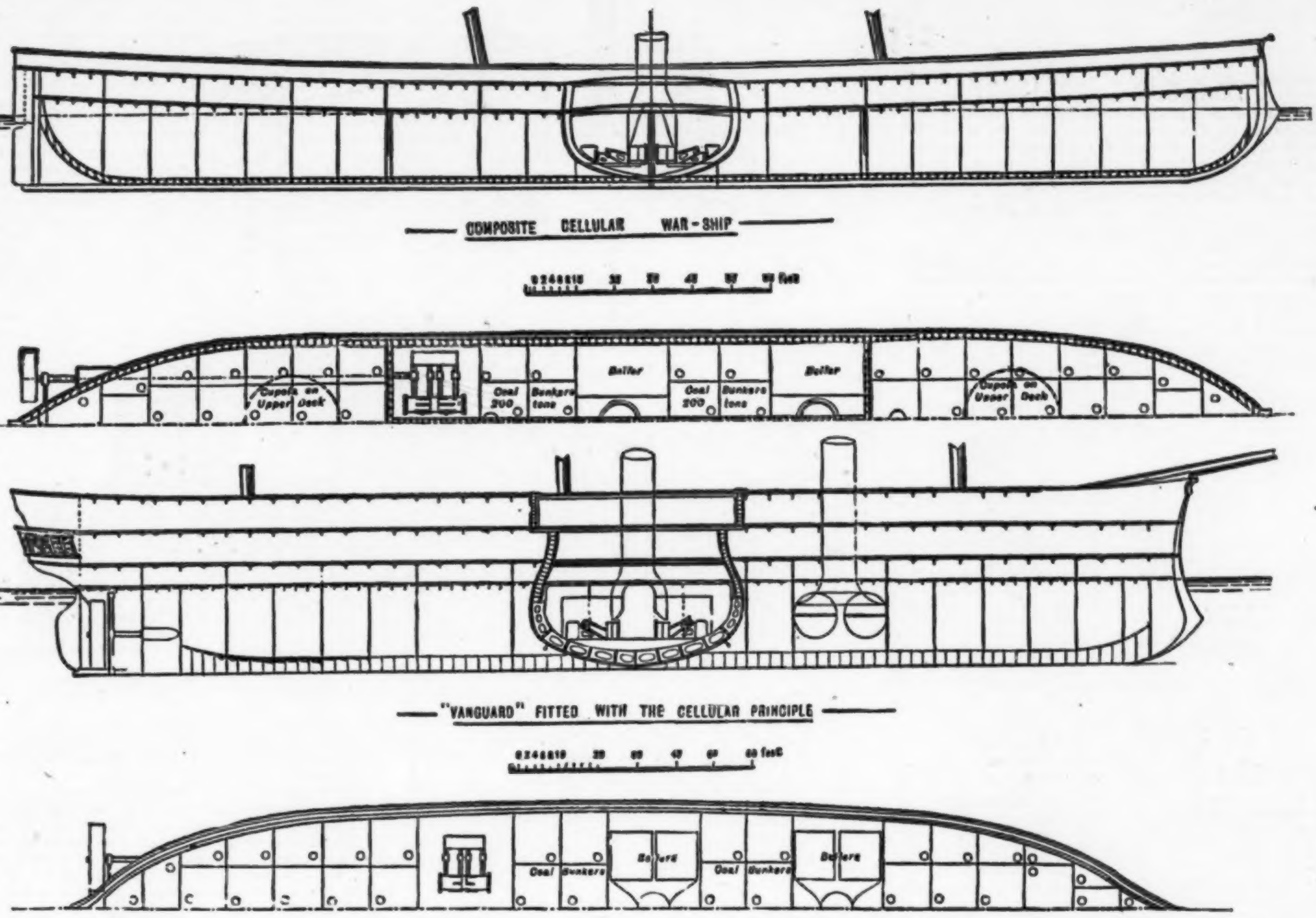
After the cranks are on their places the keys may be fitted, care being taken that, if the crank last put on had to be moved to adjust it, the sides of the keyways be filed even, otherwise drawing the key will tend to move the crank. In fitting the keys let them be a snug fit on the sides, and bear equally well all along the bottom and top, drawing them in and out during the fitting process, and easing them on the spots which show by the marks to have borne hardest in the keyway, but taking care not to drive them so tightly during the fitting as to bend them in drawing them out, which is very apt to occur in cases where a drift can not be inserted into the back end of the keyway. When a drift is used, the key should have its end edges well chamfered off, so that it will not swell from the effects of the drift, and then bind tightly in the keyway. Care should be taken to slightly oil the key before driving it in and out, otherwise it will be apt to cut and bind fast in the keyway. In case it becomes difficult to extract the key, and a drift at the small end of the key can not be used, it is necessary to hold a hammer under the projecting end of the key, to prevent it from bending from the effects of the blows, and to render the blows more effective.

CELLULAR SYSTEM FOR SHIPS OF WAR.*

By H. J. BOOLDS.

THE whole business of a war ship is to keep herself afloat while she sinks or otherwise destroys her antagonist; but, while the science of naval warfare has been directed to destruction by every means, and protection only from shot and shell, nothing is done for protection from the ram or torpedo. The power of the gun has been so much increased that the thickest armor that can be made and carried afloat is comparatively valueless for protection from shot, and worse than valueless for protection from sinking. If, therefore, a ship, even without armor, could carry her guns and fight without risk of being sunk, she would be a much more formidable antagonist than any ship of war now in existence. With the exception of the machinery, which necessarily occupies large spaces, and perhaps of coals, which may require to be frequently taken in and consumed in large quantities, there is no part of the stores of a ship of war that may not be stowed in the smallest separate compartments into which I propose to divide such ships without being in any way inconvenient to get at in emergency; even the machinery may be so divided that it may be in several water-tight compartments instead of as at present usually all in one, and there is no particular reason why coals may not be stowed away in smaller separate compartments than customary, which may be emptied in detail, and closed water-tight when empty. All iron ships have some bulkheads, usually limited in sailing ships to one collision bulkhead at the bow; screw-steamers have, in addition, one or two whole or partial bulkheads at the stern to protect the body of the ship from danger through accidents to the screw, shaft, or pipe; and two bulkheads generally enclosing the machinery, boilers, and coals. These are all that are considered absolutely necessary against usual sea risks; the holds being required to be as large free spaces as possible for general cargo purposes. In large and long vessels the two principal holds may be again divided by bulkheads into two spaces before and two abaft the engine-room; thus separating the largest ships into seven, or at most eight water-tight compartments, injury in any one of which is usually sufficient to cause a total loss. In the larger ironclads, partial protection from bottom injuries is obtained by an inner skin of iron, riveted and made water-tight upon the inner edge of the floors and frames to the height of the upper part of bilge or lowest deck. The value of this inner skin has been proved in the cases of the Great Eastern and the Agamemnon. It appears to me self-evident, that it would be an immense practical advantage to the ship if the spaces into which it is absolutely necessary to separate the stores of every kind by divisions, which are now of no other use than simply as partitions, and which only add their own weight to the weight of the stores for no benefit to the ship, were enclosed by regularly divided and permanent water-tight partitions, which would serve all the purposes for which tanks, store-rooms and magazines are now required, and contribute, in proportion to their number and arrangement, to the strength and safety of the ship, instead of being, as at present, merely dead weight, increasing the risk of her destruction. In the accompanying drawing I have shown, firstly, the composite cruiser, designed to illustrate my paper of eleven years ago on "Cellular Ships of War;" and, secondly, the Vanguard, with the lower holds altered and divided on the cellular system, to show how easy it would have been to have rendered that ship unsinkable, and how easy it would still be to make the rest of our ships of war much stronger and unsinkable, without impairing their efficiency otherwise in any respect. In the Vanguard plan I have shown the orlop beams lifted about 2 ft. to bring this deck about 1 ft. above the load line, and made a complete iron deck. The inner skin is carried up the inside of the frames and attached to this iron deck, making a complete inner ship. A longitudinal bulkhead is run through the centre line of ship from the keel to the gun-deck, or deck next above the load line. All the principal transverse bulkheads are carried up to this deck, and additional bulkheads are put in, dividing the holds into spaces 24 ft. long, making the spaces between the gun and orlop decks about 24 ft. square. Below the orlop deck the holds are again sub-divided by longitudinal and transverse bulkheads into spaces about 12 feet square, all fitted and caulked water-tight between the deck and the inner bottom, and from each

* Institution of Naval Architects.



BOOLD'S CELLULAR SYSTEM FOR SHIPS OF WAR.

other, there being no openings into these cells except by an iron water-tight door on the orlop deck, each space between the gun and orlop decks opening into four cells. In an original design it would be intended to carry each of these 24 ft. cellular spaces to the outer skin, thereby confining the water between the two skins to that space, with one water-tight opening in the inner skin for access to the frame spaces for cleaning and painting. The engine-room—from the design as a twin screw-steamer—occupies one 24 ft. space each side of central line, the next space before that being four coal cells, each 12 ft. square; then a 24 ft. boiler space, then four coal cells, then 24 ft. boiler space, and then 12 ft. cells from that to the bow, those next the forward boilers being used for coals; each cell will hold 50 tons of coals, and each group of four will hold 200 tons. Three groups on each side will hold 600 tons, or 1,200 tons of coal in all, with very little more inconvenience in trimming than ordinary bunker arrangement for such ships. The after end of the ship would be subdivided in the same way, the cells through which the screw-shafts pass being made tight around the shafts by stuffing boxes; the lower part of the cells through which the shafts pass can also be floored over the shaft, with access from the cells. All the cellular divisions are large enough for store-rooms for all purposes, and being water-tight, will serve as tanks for water and can be filled in groups wherever required for that purpose. The whole of the bulkhead cellular divisions in such a ship as the Vanguard would not exceed 500 tons weight, and as the weight of armor above necessitates as large an amount of ballast in such ships, the whole of this ballast would be saved, and the strength and safety of the ship would be immensely increased, without adding anything to the draught of water or displacement. The point A on the plan is assumed to be the place where the Vanguard was struck by the ram of the Iron Duke, as the worst possible place on which she could be struck to do the greatest injury, upon or so near a principal bulkhead that the space before and abaft would fill with water. As a cellular ship, according to the drawing, the water would be confined to the one engine-room and one or two cells adjoining; but even assuming that all the bulkheads of the adjoining cells were so much started as to make them leak and fill, the whole of the water in 48 ft. of length, half the breadth, and the height of the orlop deck would not exceed 650 tons, and would not sink her more than 2 ft. deeper in the water; while, with one engine and all her boilers intact, she would be perfectly safe to go anywhere for repair; and even had the Iron Duke been an enemy, would have been able to continue the contest without immediate fear for safety or victory. Five hundred tons of iron judiciously expended, as I have shown, on each of the ships of our present navy, at an expense of £20,000 each, would put twenty-five of them beyond the risk of such summary accidents either in peace or war, at a cost not exceeding the price of the Vanguard, which, for want of this small addition, now lies at the bottom of the Irish Channel.—*The Engineer.*

DOUBLE-SCREW TUG-BOAT.

Constructed by Messrs JAMES HOWDEN & CO., Engineers, Glasgow.

WHEN it is of sufficient diameter and is properly immersed, a single-screw propeller is probably a more effective instrument for towing than the feathering paddle-wheel; but with a screw vessel of the ordinary form, a much larger hull, or, at least, a much greater displacement is required to give sufficient immersion to a screw propeller of the size necessary for utilizing the very considerable power of a towing steamer than is demanded by a paddle steamer of the same power. Twin screws can be applied on a less draught of water, but as usually arranged they are not so efficient for towing purposes as a single-screw propeller.

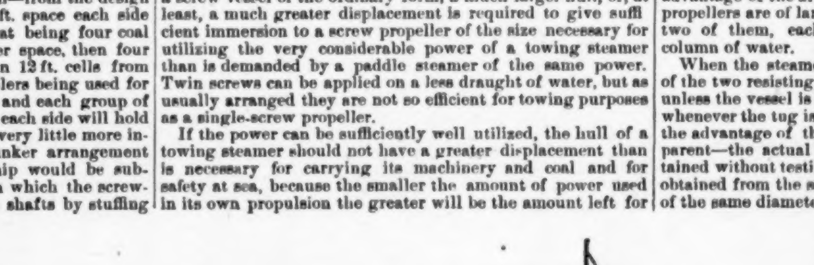
If the power can be sufficiently well utilized, the hull of a towing steamer should not have a greater displacement than is necessary for carrying its machinery and coal and for safety at sea, because the smaller the amount of power used in its own propulsion the greater will be the amount left for hauling the vessels to be towed. The arrangement of hull and propellers we now illustrate is designed to give the most favorable conditions as to the hull, and at the same time to utilize the engine power for towing to a greater extent than has heretofore been accomplished. This result is effected by constructing the vessel so as to admit of a screw propeller of large diameter being used at each end, bow and stern, and giving the proper amount of immersion to both of them by depressing the screw frames below the ordinary level of the keel. In consequence of this arrangement the hull of the vessel need be made of no greater displacement than is required for its purpose as a towing steamer, while each of the propellers is of larger diameter than the single screw of a hull of the same displacement if built of the ordinary form. The result, therefore, is that a large engine power can be most effectively used in a comparatively small vessel. The peculiar advantage of the arrangement, however, is not only that the propellers are of large diameter, but in the fact that there are two of them, each of which acts against an independent column of water.

When the steamer is only propelling itself the advantage of the two resisting columns of water is not brought into play unless the vessel is running against a strong head wind; but whenever the tug is attached to a heavy vessel outside itself, the advantage of the two screws is stated to be at once apparent—the actual effect in hauling (so far as can be ascertained without testing it by a dynamometer) being twice that obtained from the same engine power working a single screw of the same diameter and placed in the stern as usual. These results agree very fairly with those arrived at by Mr. Robert Griffiths, whose experiments on the use of bow and stern screws we have on several occasions referred to in this journal.

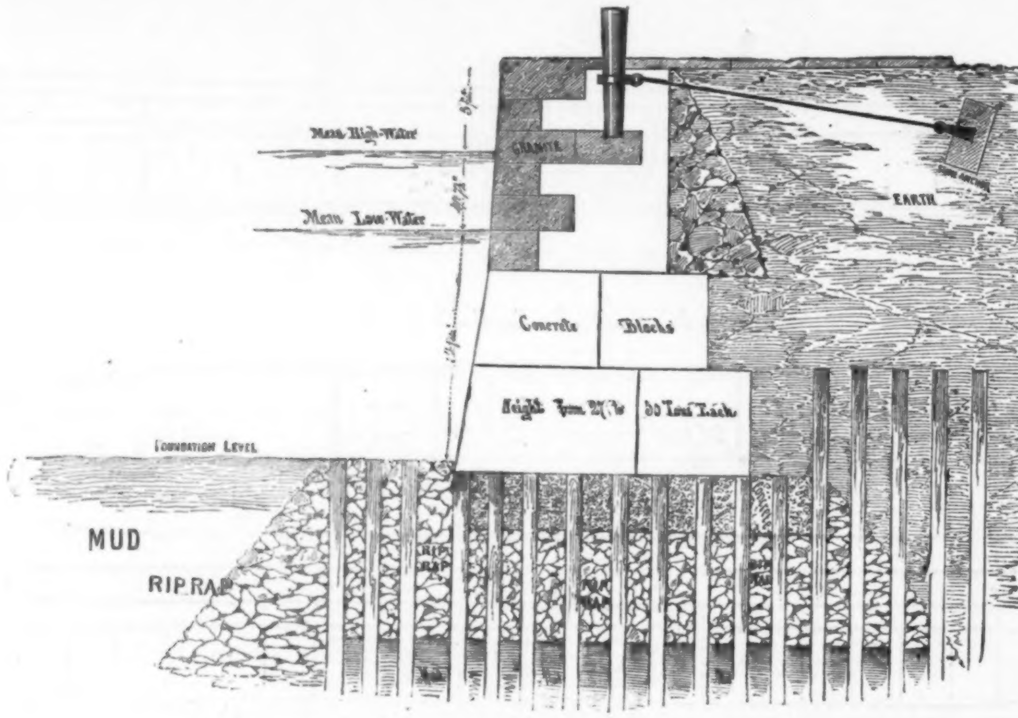
It has been found by trying one propeller only in Mr. Howden's tugs, alternately in the bow and stern, that the bow propeller gives the best hauling effect. In all probability this arises from the fact that the bow propeller works in solid or unbroken water, while the stern propeller works in the "slack-water" of the vessel.

Three of these screw tug-steamers are now at work on the Clyde—one has been in use for upwards of eighteen months, and two for about nine months. They have been built by Messrs. James Howden & Co., Glasgow, for the Screw Tug Company (Limited), and are steadily working their way into favor. So thoroughly satisfied are the directors of the company with the results obtained by the vessels, that they have unanimously resolved to recommend the shareholders to grant powers for the addition of several similar vessels to their fleet.

The vessel which we illustrate—the Clyde—was the first built of the three. It will be seen that it has both its ends alike, as it was intended principally for work in the river. The other two steamers, which are named the Forth and the Tay, have their bows formed in the usual manner, but with the screw aperture conveniently arranged and protected by means of an outguard running to the bow on the line of the rubbing belt. It will be observed that the Clyde has the screw aperture frames lower than the keel. As she never requires to take the ground this is no inconvenience. In the case of the Forth and Tay, they have a sort of double keel running straight in a line with the screw apertures at the ends. In conclusion we may remark that a thorough series of dynamometrical experiments on the performances of these tugs under different conditions would have great interest and value.—*Engineering.*



DOUBLE-SCREW TUG-BOAT.



THE NEW DOCKAGE, NEW-YORK CITY.—SECTIONAL VIEW.

THE NEW DOCKS OF NEW-YORK.

OUR engravings illustrate the general method employed in the reconstruction of the dockage of New-York City. A bulkhead wall of masonry rests upon a foundation of concrete. From this bulkhead wooden piers extend out into the river 400, 500, 600, and in a few cases even 1000 feet. A street on the North River side of 250 feet in width, and on the East River side of 200 feet, will skirt the bulkhead, affording admirable facilities for roadway, railway tracks where needed, and even storage-sheds and other structures. After the piles are driven and filled in, as represented, with "rip-rap," which are simply stones of all sizes and shapes thrown in loosely together, a foundation is levelled off in concrete. Upon this rest the concrete blocks, which are lowered into position by their own weight. A course of granite rests upon these below the low-water line. This is backed up with concrete, and another and wider course of masonry added, as shown in the drawing.

In the other engraving are shown the blocks of concrete, or Béton, as it is now sometimes called, from the French term, and the process of making them. Into the large moulds are put broken stone, trap or granite, in cubes of not over two inches, silicious sand, and Portland cement. The stones are thoroughly rammed into the sand and cement as these are added until the mould is filled. The blocks are then left to harden, which they do in a week or ten days, though they have been known to become hard enough for use in three days. For additional information concerning the building of walls for dwellings, etc., in concrete, see preceding number, of Supplement.

[The Engineer.]

TANK LOCOMOTIVES OF THE LONDON, CHATHAM, AND DOVER RAILWAY.

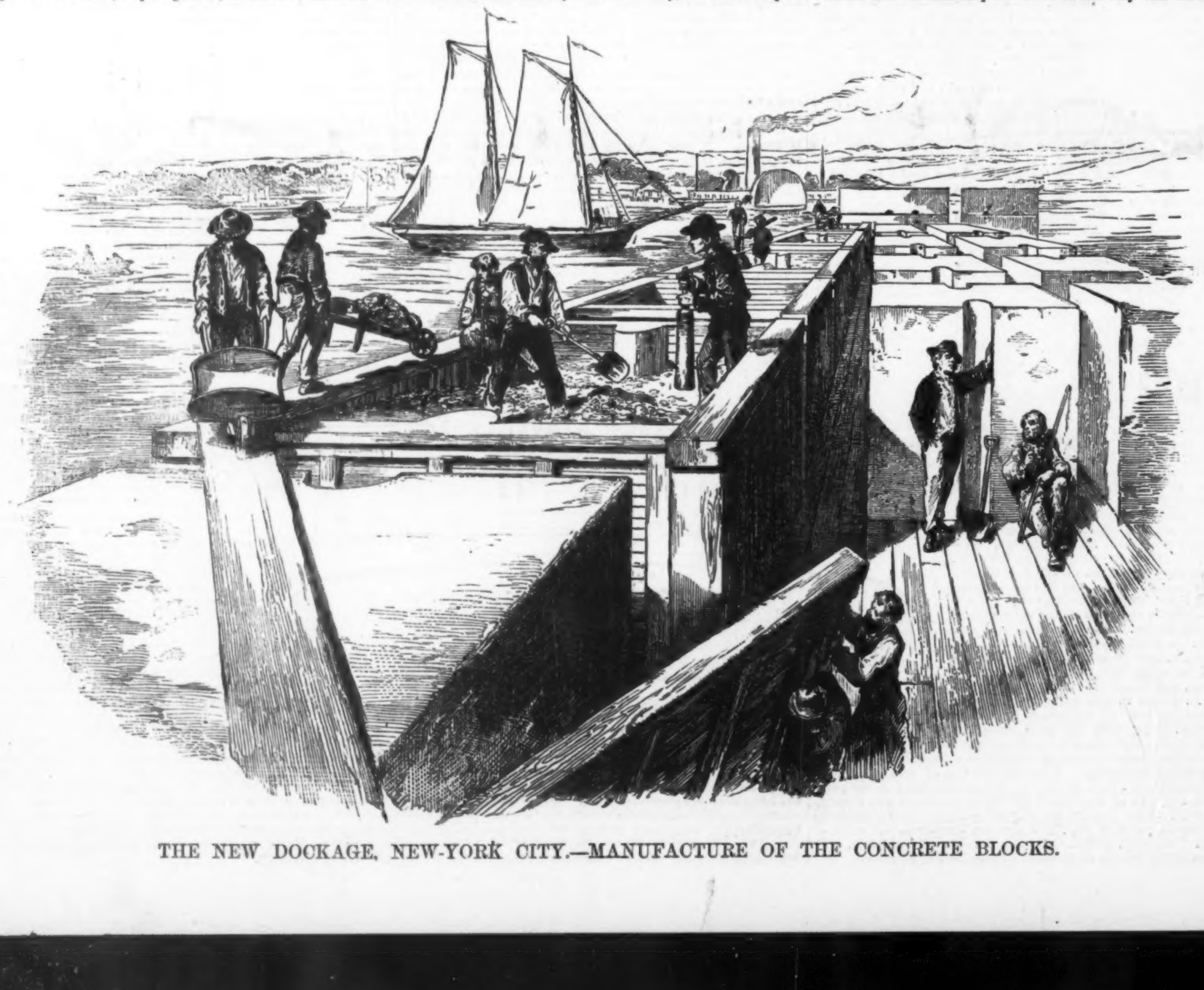
THE traffic of the London, Chatham, and Dover Railway daily grows heavier, the increase being principally, but not exclusively, confined to the Metropolitan Extension and the Crystal Palace sections. For some time back the company have been short of engine power, especially for working the heavy section of line from Snow Hill to Ludgate Hill, with an incline of 1 in 38, and the long bank from Peckham to the Palace.

To meet this difficulty Mr. W. Kirtley, locomotive superintendent of the line, designed the powerful trunk engines of which we give views on opposite page. The first of eighteen engines was delivered on the line in August, 1875, since which period they have given every satisfaction.

We publish a copy of the very carefully prepared specification from which the engines were built, as well as sectional elevations, and we shall only say now that these are among the most powerful passenger engines ever used on any railway, the cylinders being 17½ in. diameter by 26 in. stroke, while the four coupled wheels are only 5 ft. 3 in. diameter. The bogie wheels are 3 ft. diameter. The total wheel base is 20 ft., and that of the coupled wheels 8 ft. The total heating surface is 1148 ft., and that of the grate 16½ ft. The tanks hold 963 gallons of water, and the bunkers 81 cubic feet of coal.

SPECIFICATION.

General Conditions.—The engines to be made to the dimensions given in this specification, and to the drawings to be supplied by the company's locomotive superintendent, except in cases where his consent to an alteration has been first obtained in writing. The quality of the materials to be of the make specified, and where no instructions are given, both materials and workmanship are to be of the very best descrip-



THE NEW DOCKAGE, NEW-YORK CITY.—MANUFACTURE OF THE CONCRETE BLOCKS.

tion. No advantage whatever is to be taken of any omission of details in this specification, or in the drawings, as the contractors may obtain a full explanation of any part of the work not sufficiently shown or understood. The engines must be finished, in every respect, in the most complete manner, and to the entire satisfaction of the company's locomotive superintendent, who shall be at liberty to inspect, either personally or by deputy, the work during its progress, and to reject any defective or unsuitable materials or workmanship. In case of any dispute arising, either during the progress of the contract or at its termination, the decision of Mr. W. Kirtley, the locomotive superintendent of the company, is to be taken as final and binding in every respect. The engines are to be delivered by the builders free of charge to the London, Chatham and Dover Railway Company, at Longhedge Works, fit and ready for work; and prior to payment each engine will be required to run 1000 miles (consecutively) without showing any defect in materials or workmanship, and the builders will be held responsible for all defects that may appear (accidents excepted) until they have run that distance. All royalties and patent rights must be paid by the contractors.

Quality of Materials.—Iron: In all cases where "best iron" is specified, it must be wrought iron of the manufacture of either Low Moor, Bowling, Taylor, Cooper, Monkbridge, or Farnley (best Yorkshire) iron; and the manufacturer's brand must be where it can be seen when the part of the engine in which it is used is finished.

Brass and Gun Metal.—Where brass is specified, it must be of good tough metal. Gun metal must be composed of five parts of copper to one part of tin.

White Metal.—This must be composed of—tin, sixteen parts; antimony, two; copper, one and a half. Other materials to be obtained of the manufacture to be hereinafter specified, unless the consent of the company's locomotive superintendent, in writing, be first obtained to an alteration.

Boiler.—Barrel, dome, fire-box shell, and smoke-box tube plate, and all angle irons, rivets, and stays to be made of Low Moor, Bowling, Taylor's, or Cooper's (best Yorkshire) iron. Barrel to be made of three plates, as shown; transverse joints to be made with a butt strip ring, and to be single riveted; longitudinal seams to be butt jointed, and to have inside and outside strips, and to be double riveted; seam of middle plate to be welded, and to have a strip riveted on inside to form a strengthening ring for dome hole, as shown on drawings. Tube plate to be secured to barrel by a ring of angle iron, bored, faced, and turned on the edges, and to be zigzag riveted to both. The dome to be in one plate, welded at the seam, and flanged at the bottom to fit the barrel; to have an angle iron ring in the top, and to be fitted with a cast-iron cover. The cover and angle iron must be accurately faced, so as to make a perfectly steam-tight joint. The fire-box foundation ring to be of the form shown, so that the casing plates may be double riveted at the corners. All iron used in any part of the barrel or fire-box shell to be "best iron." All rivets must completely fit the holes, and the heads must be perfectly true and central; the holes must be slightly countersunk, and drilled or punched, and rhymed out, perfectly fair with each other in all plates and angle irons. No drifting will be allowed. Any caulking that may be required must be done with a broad-faced tool, so that the plates may sustain no injury. Great care must be taken that the plates are brought well together before any rivet is put in. All plates are to be planed or turned on the edges before being put together. Suitable wash-out plugs and mud doors are to be placed as shown on drawings. Girder stays are to be fixed to the tube plate, gusset stays to the back plate, and other stays to be placed as shown on drawings. Before being lagged the boiler is to be tested in the presence of the company's locomotive superintendent, or his inspector, to a pressure of 200 lbs. per square inch with water, and afterwards to 150 lbs. with steam, and it must be tight under these pressures.

DIMENSIONS:

	ft.	in.
Length of barrel between plates	10	11
Diameter, outside	4	3
Thickness of plates	0	0½
Thickness of tube plate	0	0¾
Thickness of dome	0	0½
Diameter of rivets	0	0 13/16

Fire-box Shell.

	ft.	in.
Length, outside	5	6
Breadth at bottom, outside	4	1
Bottom of foundation ring below centre line of boiler	4	11½
Thickness of plates	0	0½
Average distance of copper stays apart	0	4
Diameter of copper stays	0	0¾
Diameter of rivets	0	0 13/16
Diameter of foundation ring rivets	0	0¾

Smoke-box.—Plates of smoke-box and door to be of B.B Staffordshire iron, having a perfectly smooth surface. Rivets to be countersunk outside.

DIMENSIONS:

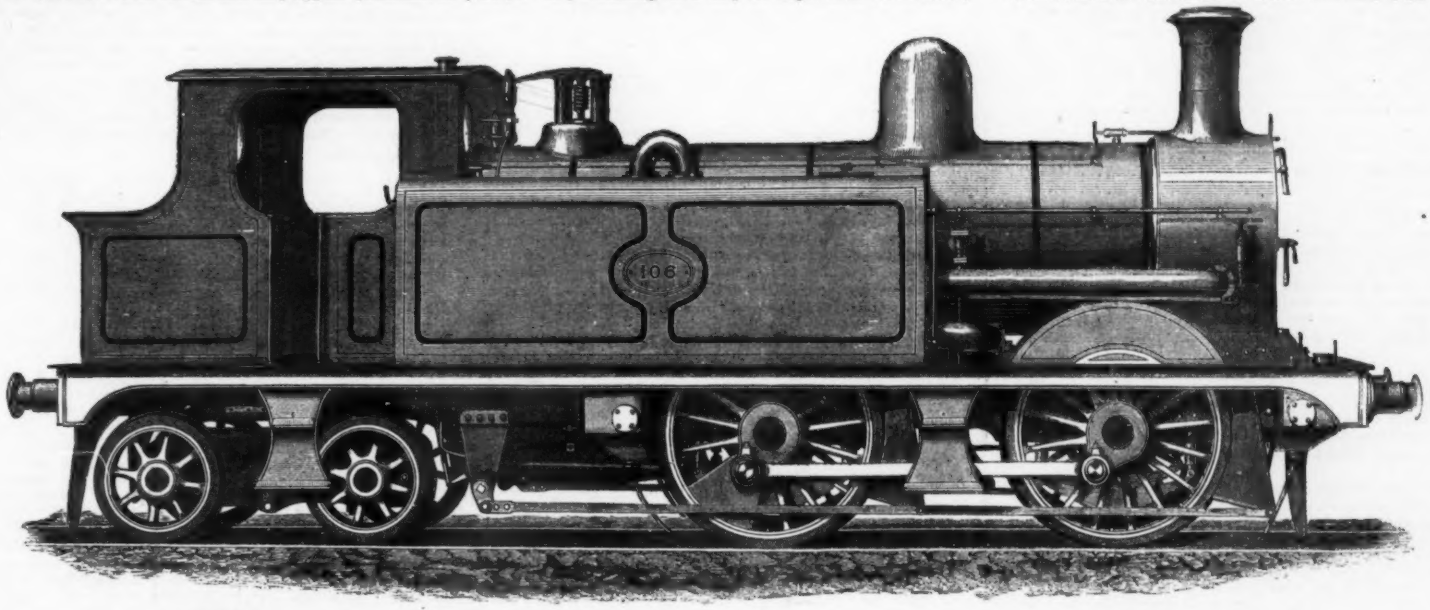
	ft.	in.
Length, inside	2	8½
Width inside on centre line of boiler	4	11
Thickness of plates	0	0⅜
Angle iron	2½ in. by 2½ in. by 7/16 in. –	–
Diameter of rivets	0	0¾
Pitch	0	2¼

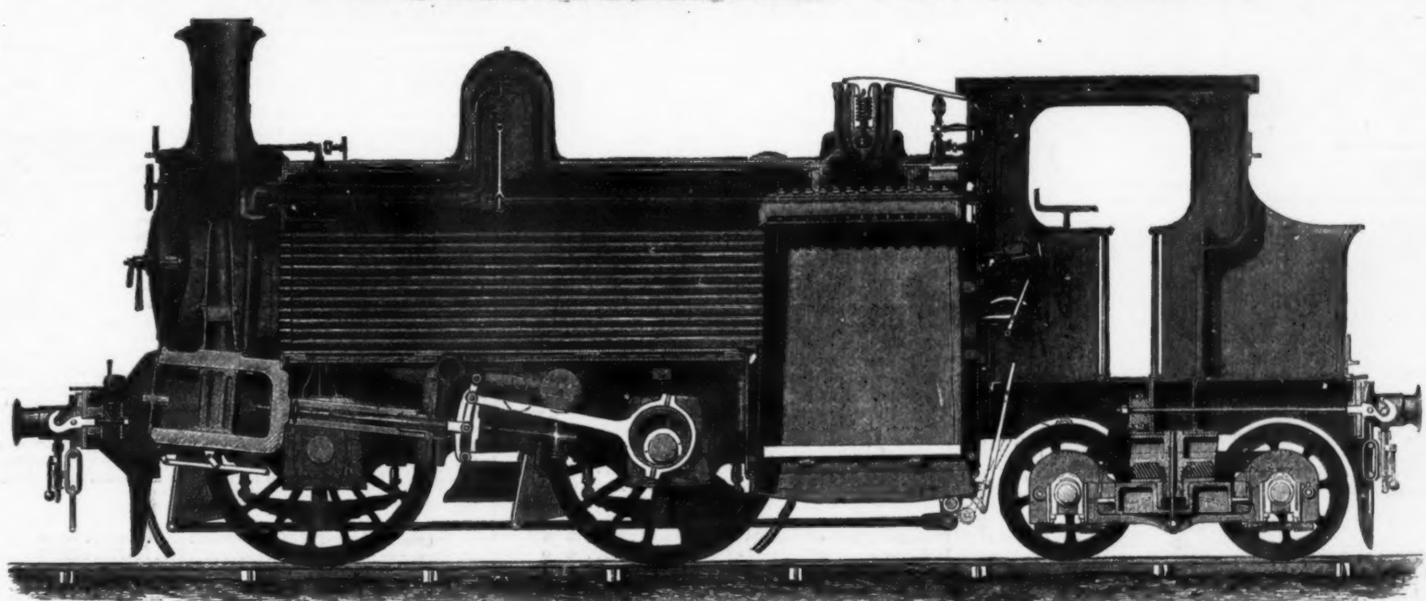
Chimney.—To be made of B.B. Staffordshire or Yorkshire iron; joint to be butted down the back, and the rivets to be countersunk on the outside. The bottom to be quite free from hammer marks, and carefully fitted to smoke-box. The top of cast iron, to be made accurately to drawing.

DIMENSIONS:

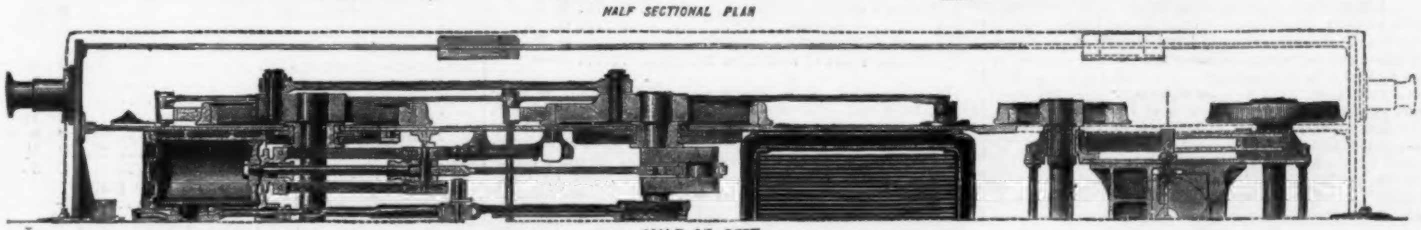
	ft.	in.
Height of top from rail	12	6
Diameter inside at top	1	4
Diameter inside at bottom	1	3
Thickness of plates	0	0¼

Fire-box.—Copper for fire-box and stays to be of the very best quality, and obtained from Messrs. Grenfell & Sons, Vivian & Sons, or other approved makers. Copper stays to be of the best soft rolled copper bars, and the plates to be an-





HALF SECTIONAL PLAN



SCALE OF FEET

TANK LOCOMOTIVES OF THE LONDON, CHATHAM AND DOVER RAILWAY. *Designed by W. Kirtley.*

nealed and to stand a test of being doubled cold without showing any sign of fracture. One brass plug with fusible centre, to be inserted in the crown of the fire-box; the copper stays to be screwed into the fire-box plates and shell plates, and to be riveted over at the ends, the thread being turned off the portion of the stay between the plates. Fire-bars to be of wrought iron, supported as shown on drawings.

DIMENSIONS:

	ft.	in.
Length at top, outside	4	9¼
Length at bottom, outside	4	10¾
Breadth	3	6
Depth inside	5	6¼
Water space at bottom, all round	0	3
Thickness of plates	0	0½
Thickness of tube plate.......⅞ in. and ½ in.	–	–
Fire-hole, diameter	1	4
Section of fire-hole ring....3½ in. by 2¾ in.	–	–
Roofs stays..........Number 8.	–	–
Depth......6 to be 6 in., and 2 to be 5½ in.	–	–
Thickness..........two plates, each	0	0⅝
Rivets, copper	0	0[illegible]

Ash-Pan.—To be made, as shown on drawing, to hold water, and to be fitted with a door or damper, front and back, each to be worked separately from foot-plate.

DIMENSIONS:

	ft.	in.
Thickness of plates	0	0¼
Angle iron.........2 in. by 2 in. by 5/16 in.	–	–
Diameter of rivets	0	0½

Tubes.—To be made of 70 parts copper and 30 parts Silesian spelter, and to be solid drawn, of either Everitt's, Green's, Wilkes', Birmingham Battery Company's, or other approved make. To be fixed with ferules at the fire-box end, and carefully secured by a a roller tube expander. Ferules to be of ferule steel, or best malleable cast-iron, and to go into the tubes a tight driving fit.

DIMENSIONS:

	ft.	in.
Number 202	–	–
Length between tube plates	11	3
Diameter outside	0	1¾
Diameter outside at smoke-box ends..1⅞ in. for 3 in.	–	–
Thickness at fire-box end.........12 W.G.	–	–
Thickness at smoke-box end.....14 W.G.	–	–
Distance apart of centres	0	2½

Safety Valves.—To be of the kind known as "Ramsbottom's duplex" safety valves, the columns and manhole cover to be of cast-iron, solid. A brass bush to be inserted in each column for the valve seat. The springs and gear to be made accurately to drawings, and to be screwed down so as to blow off at 140 lbs. per square inch. The seating for these valves to be of malleable cast iron, riveted to the fire-box shell. The cover and seat must be accurately faced, so as to make a perfect steam-tight joint.

DIMENSIONS:

	ft.	in.
Diameter of valves	0	3¼
Distant apart of columns	0	10 5/16
Height of columns	1	7
Diameter of spring steel, Salter's make	0	0[illegible]

Regulator and Steam Pipe.—Regulator to be of cast-iron, with double slides of brass and cast-iron; the steam pipes to be of copper sheets No. 7 W.G., and hard soldered together on the inside, flanges to be brass; branch pipe in smoke-box to be cast-iron; steam pipe to be secured to regulator by means of four bolts.

DIMENSIONS:

	ft.	in.
Diameter of steam pipe, inside	0	4½

Blast Pipe and Condensing Apparatus for Metropolitan Tunnel Working.—The blast pipe to be of cast-iron, and to be fitted with cast-iron branch pipes communicating with the tanks, and to have valves for opening or closing the main pipe or the branches. The valves to be worked by suitable gear from the engineman's foot-plate.

DIMENSIONS:

	ft.	in.
Diameter at nozzle, inside	0	5½
Height above top row of tubes	0	2

Cylinders.—To be made of the best close-grained, hard and strong, cold blast cast-iron, twice cast, and as hard as can be worked, and perfectly free from honeycomb or other defects. They must be truly bored out, the ends being bell-mouthed. The cylinders are to be made with loose covers at each end, the back cover having provision for carrying the slide bars. All joints and faces to be machined and scraped to a true surface, so that a perfect joint can be obtained. The cylinders to be set as shown on drawing, and to be secured to the frames by flanges, the holes in which and in the frames are to be rose-bitted, and to have turned bolts a driving fit. To be provided with waste water cocks and gear, to be worked from the foot plate. The top of cylinders to be covered with thin fire-brick or cement, the underside to be lagged with wood, and covered with sheet-iron.

DIMENSIONS:

	ft.	in.
Diameter	0	17½
Stroke	0	2[illegible]
Distance of centres	2	4
Distance of valve spindle centres	0	3½
Thickness of metal	0	0⅞
Length of ports	0	14
Width of steam ports	0	1½
Width of exhaust port	0	3½
Thickness of bridges	0	1
Length of working faces	0	11
Distance from centre of driving axle to centre of exhaust port	10	5½
Incline of cylinders...........1 in 10½	–	–

Pistons.—To be of good tough cast-iron, made from cylinder metal, and to be sound and free from all defects, to be accurately fitted to cone on end of piston rod, and fixed with a nut as shown on drawings. Piston head to be turned 1/16 in. smaller than bore of cylinder. Packing rings (two in each piston) to be of cast-iron turned on outside and on edges, and made ⅛ in. larger than cylinder bore, and then cut and sprung into their places. The piston to have a small spring and tongue-piece on under side, as shown on drawings. The whole must be an easy but accurate fit in the cylinder, so that the piston and rod can be moved backwards and forwards by hand.

DIMENSIONS:

	ft.	in.
Width	0	3½
Width of rings, two in each piston	0	0⅝
Thickness of rings	0	0½

Piston Rod.—To be of the best cast steel, manufactured by Taylor Brothers, Vickers, Sons & Co., Cammell & Co., or other approved makers, with cone and nut for fixing to piston; the cone at crosshead end to be enlarged as shown on drawing. Diameter of rods, 2¾ in.

Crosshead and Gudgeon Pin.—To be of "best Yorkshire iron," and to be finished bright, the gudgeon pin to be well case-hardened.

Slide Valves.—To be of gun-metal with spindle frames of "best Yorkshire iron," of the form shown on drawings, and the valves to have ⅛ in. holes drilled in the face.

DIMENSIONS.

	ft.	in.
Lap	0	1
Lead in full gear	0	0 3/16
Centre line of valve above centre line of cylinder	0	1

Valve Motion.—All wrought-iron to be "best iron," and the working and rubbing surfaces to be thoroughly case-hardened and finished in the best manner. Expansion link to be lifted by the middle, the weight-bar shaft being above the motion and behind the link. All the motion pins to be of "best iron," thoroughly case-hardened and accurately fitted. Eccentric sheaves to be in two pieces, the smaller piece being of "best iron," and the larger piece of cylinder metal. Eccentric straps to be of wrought iron, fitted with white metal liners. The intermediate spindle guides to be of cast iron, bushed from either end with gun-metal bushes, and to be provided with the necessary oil siphons.

Slide Bars.—To be of cast steel from the same makers as piston rods; the slide blocks to be of sound castings of cylinder metal, and free from all defects.

DIMENSIONS:

	ft.	in.
Width	0	2½
Thickness	0	2
Length	3	11

Reversing Gear.—Reversing to be performed by means of a screw arrangement; to consist of a gun-metal nut, having a wheel attached, working in a cast-iron guide and actuating an eye bolt connected to the reversing rod. The guide to be carried on a suitable box support attached firmly to the foot-plate. The whole of this to be made accurately to drawings.

Connecting Rods.—To be of best Yorkshire iron, forged in one length, without welding, brasses to be lined with white metal.

DIMENSIONS:

	ft.	in.
Distance of centres	6	6
Diameter of bearing, big ends	0	7½
Diameter of bearing, small ends	0	3

Coupling Rods.—To be made of best Yorkshire iron. To be made with solid ends and gun-metal bushes. Each rod to be forged solid in one length.

Coupling Rod Pins.—To be of Bessemer or crucible steel of approved make; to be accurately turned to gauge, and to be exact duplicates one of the other; to be forced into the wheels by hydraulic pressure, and afterwards riveted over; the outside end of pin to be fitted with a washer and taper pin as shown on drawings.

Axles, Driving and Leading.—To be made of best Yorkshire iron, of approved make; all corresponding parts to be of an exact size and made to template, so that they may be interchangeable, and they must be clearly stamped with the maker's name.

DIMENSIONS:

Driving.	ft.	in.
Diameter in middle	0	7
Diameter on wheel seat	0	9
Diameter of bearing	0	7½
Length of bearing	0	7½
Diameter of crank-pin bearing	0	7½
Distance apart of centres of cranks	2	4
Distance apart of centres of bearings	4	0
Cross section of crank-arm...12 in. by 4½ in.	–	–
Leading.		
Diameter in middle	0	7
Diameter on wheel seat	0	9
Diameter of bearing	0	7½
Length of bearing	0	7½
Distance apart of centres of bearings	4	0

Axle-boxes and Horn Blocks.—Axle-boxes to be of gun-metal, lined with white metal, and fitted with cast-iron keeps, and arranged for spring lubricating pads. Every axle-box must be made accurately to dimensions, so as to be interchangeable with any or all the engines; and the same condition applies to all the working parts, which must be exact duplicates. The horn blocks to be solid, and of Vickers', Cammell's, Taylor's, or other approved make of steel, provided with adjusting wedges and securing bolts. The horn stays are to clip both the frame and the horn block in the manner shown on drawings. Great care must be taken to fit these horn stays accurately to both frame and horn block. Care must also be taken to bed the horn blocks accurately on to the frames.

Wheels, Driving and Leading.—To be of wrought-iron, of the best materials and workmanship, with solid rims, spokes, bosses, and balance-weights, as shown in drawings. Each wheel must be put on the axle by hydraulic pressure of not less than 45 tons, and then keyed on. Great care must be taken that the keys fit accurately.

DIMENSIONS:

	ft.	in.
Diameter on rim	4	9
Width of rim	0	4¾
Thickness	0	1¾
Number of spokes, 16	–	–
Diameter of boss	1	5½
Width of boss	0	7½
Diameter of hole in boss	0	9
Centre of wheel to centre of coupling pin	0	11
Centre of leading to centre of driving wheel	8	0

Tires.—To be crucible cast-steel, manufactured by Taylor Brothers; Vickers, Sons & Co.; Cammell & Co.; Monkbridge & Co.; Bowling Iron Company, and to be of the section shown on drawing, to be shrunk on, and fixed to wheel by a lip on one side and by screws ⅝-in. diameter, placed between each spoke, as shown on drawings.

DIMENSIONS:

	ft.	in.
Diameter on tread	5	3
Width	0	5½
Thickness on tread	0	3

Frames.—To be of Yorkshire iron, frame-plate quality, made by Taylor Brothers, Cammell & Co., Brown & Co., Parkgate Iron Company, or other approved makers. Each frame plate must be in one length—if welded, the weld to be not less than 3 ft. behind the driving axle—and it must have the brand of the manufacturer on it. All surfaces to be planed where any attachment is made, and all holes to be marked from one template, and drilled and rhymed to the exact size given. When the frames and cylinders are erected the accuracy of the work must be carefully tested by diagonal, longitudinal, and transverse measurement. Frames to be finished with a good, smooth surface. A transverse stay must be placed so as to carry the motion-bars and the intermediate spindle-guide. Stays must be placed front and back of the firebox casing; and two vertical flanged stays, having a horizontal plate attached to them and to the frames by an angle-iron, must be placed behind the fire-box casing to carry the bogie centre pin. These cross-stays must be carefully riveted to the frame-plates.

DIMENSIONS:

	ft.	in.
Thickness of frames	0	1
Depth	1	6
Distance from centre of leading axle to end of frame	5	4
Distance from centre of leading axle to centre of driving axle	8	0
Distance from centre of driving axle to centre of bogie	12	0
Distance from centre line of bogie to end of frame	4	4
Extreme length of plates	29	8
Distance from centre line of driving axle to front of fire-box casing	2	0
Distance from centre line of leading axle to back of smoke-box tube plate	0	11
Distance between frames	4	2
Height of top of frame from rail	4	1½

Outside Frames.—To be of angle iron, the step-plates to be riveted on, and to have the ends deepened, and to be stayed to the main frames, as shown on drawings. Section of angle-iron for frames 6 in. by 2½ in. by ½ in.

Bogie, William Adams' Patent.—To be constructed to dimensions and drawings. To be provided with four wheels. The carrying girders to be of cylinder metal, cast solid, and machined on all working and attached surfaces, and securely riveted to the frames, and so arranged as to allow a sliding block, also of cylinder metal, to work in and upon them. This block to have side play, controlled by suitable india-rubber check-springs. The engine is supported on a ring of india-rubber, resting in a brass dish, on the sliding block, through which ring and into the sliding block passes the bogie pin before mentioned—the india-rubber ring and check springs to be of George Spencer & Co.'s make. Horn blocks of cylinder metal are to be well riveted, by countersunk rivets, to the frames, and are to have cast-iron distance blocks and securing bolts, as shown on drawings. The axle boxes to be of gun-metal, fitted with cast-iron keeps, and arranged for spring lubricating pads. The springs are to be attached to the frame and compensating beams, as shown on drawing. The wheels to be of wrought-iron, to be put on the axles by hydraulic pressure of not less than 45 tons, to have no keys, and to have steel tires of the same make and mode of fastening to the wheels as the coupled wheel tires. The axles to be of best Yorkshire iron of approved make, and to be clearly stamped with the maker's name; all corresponding turned parts to be exact duplicates, so that the wheels and axles may be interchangeable in all the engines. The bogie frames to be of wrought-iron, raised, as shown on drawings, over the axles, and to be stayed by the girder casting before mentioned, and by two round stays at the ends, these stays passing through the frames and the horn blocks and secured by nuts.

DIMENSIONS:

	ft.	in.
Distance of centres of wheels	5	0
Diameter of wheel frames	2	6
Number of spokes, 8	–	–
Diameter of tires on tread	3	0
Thickness of tires	0	3
Diameter of axles in middle	0	5½
Diameter of axles at bearing	0	6
Diameter of axles on wheel-seat	0	6½
Distance of centres of bearings	3	7
Length of bearings	0	9
Depth of frames	0	9½
Thickness of frames	0	0⅞
Distance apart of frames	2	7½
Diameter of rubber ring	2	0
Thickness "	0	4½
Lateral play of sliding-block	0	2
Section of compensation beams, two plates, each 5 in. by 1 in.	–	–

Springs for Coupled and Bogie Wheels.—To be made of best spring steel, manufactured by Messrs. Turton & Sons, Cammell & Co., or other approved makers. Before being put on the engine each spring is to be fully tested until half the camber is taken out, and the spring must afterwards resume its original form. The buckles for driving and trailing springs are to be extended upwards for attachment to the axle-box, as shown on drawings. These springs are to be connected to wrought-iron brackets by links provided with a screw adjustment, and thoroughly case-hardened. All the pins connected with the springs must be of wrought-iron, and case-hardened.

DIMENSIONS:

Springs for Coupled Wheels.	ft.	in.
Length loaded	3	6
Camber "	0	3½
Breadth of plates	0	4½
Number " 12	–	–
Thickness "	0	0½
Springs for Bogie Wheels.		
Length loaded	3	6
Camber "	0	3½
Breadth of plates	0	4½
Number " 12	–	–
Thickness "	0	0½

Buffer and Buffer Plates.—Buffers to have wrought-iron cases, and to be, in all respects, similar to drawing supplied. To be obtained from Messrs. Cammell & Co., Brown & Co., or George Spencer & Co. Buffer plates to be of wrought-iron, and to be fitted with suitable drag chains and couplings. Drag chains to have india-rubber springs, to drawing. Rail-guards are to be attached to buffer plates and frames, as shown on drawings.

DIMENSIONS:	ft.	in.
Depth of plates	1	4
Length "	8	2
Thickness	0	1¼
Height of centre line of buffers from rail	3	5
Distance of buffers apart	5	8
Foot-plate to be of iron ⅝ in. thick	–	–

Tanks, 963 *Gallons.*—Tanks, one on each side of boiler, to contain 963 gallons. To be made of B B Staffordshire iron plates, with angle irons, stays, and manhole fittings, as shown on drawings; the bottom of tank to stand off the foot-plate. The tanks to be fixed to the foot-plate by angle irons, and to be stayed to the boiler by suitable stays. The tanks are to be connected by a cast-iron connection pipe; an outlet valve to be fitted to one tank, and to be worked from foot-plate. They are to be neatly lagged with smooth sheet-iron covering plates. A condensing arrangement is to be fitted to the tanks, as shown on drawings. Brass number plates, to drawing, to be fixed on the tanks.

DIMENSIONS:

	ft.	in.
Length of tanks	12	0
Width "	1	8¼
Height "	4	8
Thickness of plates	0	0¼
Angle irons 2 in. by 2 in. by $\frac{5}{16}$ in.	–	–
Diameter of rivets	0	0¾
Diameter of connection pipe, inside	0	6
Diameter of outlet valve	0	8

Cab.—To be made of best Staffordshire plate, ¼ in.—full—thick, and fitted with four plate-glass windows in brass frames, to be made to open. All rivets to be countersunk outside. The cab to be constructed, in all respects, to drawings.

Coal Box, 81 *Cubic Feet.*—To be made of best Staffordshire plates ¼ in. thick, and angle irons 2 in. by 2 in. by $\frac{5}{16}$ in., and riveted with ¾ in. rivets, countersunk outside.

Boiler Mountings.—A brass stand pipe to be fitted on to fire-box casing in front of cab, to carry two whistles, one injector steam-valve, one warning valve, and one pressure gauge-cock. Pressure gauge to be on Bourdon's system, with solid drawn tube, to sample supplied, to indicate from 1 lb. to 200 lbs. per square inch. A blower of approved construction to be fixed on boiler and worked from the foot-plate. Two glass water-gauges, two clack boxes, one for the injector and one for the pump, and cylinder lubricators, to be suitably fixed; the whole to be made of brass, and of first-class finish.

Injector and Pump.—One injector and one pump to be fitted to the engine. The injector to be Friedman's brass No. 9, to pattern, to be supplied by Messrs. Sharp, Stewart & Co. The pump to be of approved construction, and worked from slide block.

Lagging.—The boiler and fire-box shell to be lagged with well-seasoned pine, and covered with smooth iron sheets 14 W. G., which are to be secured on a light-wrought frame, by screws and bolts, as shown on drawings.

Dome and Manhole Covers.—To be of charcoal-iron, thoroughly well-finished.

Sand Boxes.—To be of cast-iron, four in number, and fitted with valves and substantial gear for working from the foot-plate; the two leading and two trailing, respectively, to be coupled together.

Bolts and Nuts.—To be made to drawings and gauges, and all threads to be Whitworth's standard. Every nut of the same description, to be exactly the same size. All gland nuts to be case-hardened.

Brake.—A powerful brake-arrangement, for both leading and driving wheels, to be fitted to the engine, with levers and screw, as shown on drawings. All pins and working surfaces of the brake-gear to be well case-hardened. A cast-iron column, for brake-screw, to be fixed on foot-plate.

Hand-Rail.—A neat hand-rail to be provided at the leading end of the boiler, supported by polished wrought-iron standards. Lamp-irons to be fixed front and back of engine, as shown on drawings.

Tools.—Each engine to be provided with a complete set of spanners; one large and one small shifting-spanner; one heavy and one hand hammer; one lead and one copper hammer; one large and one small pin-punch; one screw-jack of approved construction; six chisels, one crowbar, one tallow kettle, one oil-can, and one oil feeder, and all the necessary fire-irons.

Painting.—The boiler to receive two coats of oxalic paint before being lagged with wood; and the wood lagging to have one coat of lead-color before the plates are put on. Then the lagging, tanks, cab, coal-box, splashers, frames, wheels, axles, and all necessary parts of the engine to be painted as follows: Clothing-plates, tank, cab, and coal-box plates to receive two coats of oxalic paint, one coat of stopping, two coats of oxalic paint, two coats of green, to sample supplied, and three coats of finishing varnish. Frames to be painted brown, the coats to be prepared the same as clothing plates and tanks. Wheels, two coats of lead color, one coat of stopping, rubbed down, two coats of oxalic paint, two coats of green, and two coats of varnish. Buffer-plates to be prepared same as clothing-plates, and painted vermilion. Axles to be finished with one coat of vermilion and one coat of varnish. Panelling and fine lining to be painted to sample supplied. Smoke-box, chimney, back of fire-box casing, platforms, steps, guards, to be painted black. Two coats inside cab to be prepared similar to boiler and frame, and finished in brown and lined. Tenders sealed and indorsed, "Tender for four-wheels coupled bogie tank-engines," must be lodged at the Secretary's office, Victoria Station, London, Chatham, and Dover Railway.

ACCIDENTS ON THE GERMAN RAILWAYS.

FROM the official list of accidents in 1875 on the German railways, not including Bavaria, we learn that there were 755 collisions and cases of trains being thrown off the rails while running, and 1376 similar collisions while shunting. There were 1250 accidents of various kinds, which caused an interruption of the traffic. The lives of 509 persons were lost, and 1545 people were more or less seriously wounded. One passenger was killed in every 11,402,067, and one wounded in every 2,443,300. The proportion of accidents to the number of trains, was one in 5394 passenger trains, and one in 2290 goods trains.

IMPROVEMENTS IN ELECTRO-MAGNETS AND INDUCTION COILS.

By Prof. JOHN TROWBRIDGE.

IN a paper presented to the American Academy of Arts and Sciences, April 13, 1875, I showed that the application of armatures to two straight electro-magnets, which formed the primary circuit of a Ruhmkorff coil more than doubled the strength of the induction current produced by breaking the primary circuit. When, however, the circuit of the secondary coil was not closed, and a spark was allowed to jump across the interval between its poles, the striking distance of the spark and its power to charge a condenser did not seem to be notably increased by the application of armatures to the electro-magnets of the primary circuit. My experiments at that time were made with solid iron cores; and I now resume these experiments with bundles of fine iron wires in place of the solid iron cores. The mechanical difficulty of making the ends of the bundle of fine iron wires constituting the cores plain surfaces was overcome by dipping them in melted solder and then filing the ends smooth. In this way I had no trouble in applying the armatures so that they should lie upon a plain surface. The resistance of each of the two induction coils covering the two straight electro-magnets was 6000 ohms; and that of each of the straight electro-magnets, .34 of an ohm. The diameter of the bundles of fine iron wires constituting the cores was 5 cm. and the length of the electro-magnets 28 cm. Condensers of various sizes were placed in the primary circuit. The results given in this paper were obtained by the use of a condenser of about one farad. The method of experimenting was to charge a condenser of one-third of a farad; and then to discharge this condenser through a galvanometer. If we express the quantity of electricity received by the condenser by Q, the electromotive force by E, and the capacity of the condenser by C, we have $Q = \frac{2nt}{\pi} \sin \frac{1}{2}\theta$, where n is the reduction factor of the galvanometer, t the time of vibration of the magnet, and θ the angle through which it swings under the effect of the change. Knowing the reduction factor of my galvanometer, I had thus the means of reducing my results to absolute measure. But I speedily found that the relative results obtained by the proportions

$$Q : Q' = \sin \tfrac{1}{2}\theta ; \sin \tfrac{1}{2}\theta' = E : E'$$

would present the points of this investigation in as clear a manner as if the results had been reduced to absolute magnetic measure. My first experiments were made with solid armatures.

TABLE I.

Without armatures. Tan θ.	With armatures. Tan θ'.
80	90
70	80
90	100
60	70
70	85
80	90
Mean, 75	86

TABLE II.

Without plates.	With plates.
80	400
70	380
90	370
60	400
70	370
80	400
Mean, 75	Mean, 386.6

In Table I. the numbers are the deflections of the reflecting galvanometer expressed in millimetres, and the distance of the scale from the magnet was one metre. In this case the gain by the use of the armatures was trifling, being only about fourteen per cent. These results were obtained by charging the condenser of one third of a farad, by sparks one millimetre in length. On a closed secondary circuit, however, a gain of one hundred per cent. was clearly seen in the strength of the induced currents produced by breaking the primary circuit. The question, how to make this increase in the strength of the induced current by the employment of armatures apparent on a broken secondary circuit, became an interesting one. It seemed at first as if the application of armatures, by maintaining the temporary magnetization of the iron cores would be detrimental rather than otherwise. I next tried the effect of bundles of thin iron plates, which were placed, as armatures, upon both poles of the electro-magnet, thus making a magnet of a horse-shoe form. On charging the condenser, I found a very great increase in quantity, which was manifested by the swing of the galvanometer needle; the indicator being entirely off the scale.

Table II. shows the results obtained by the use of iron plates one and one-quarter of an inch in thickness, twenty in number, constituting each armature.

Here a gain of four hundred per cent. was manifested by the use of thin plates. The next step was to ascertain how many plates were necessary to obtain the maximum effect. The difficulty of obtaining plates of the same homogeneity made it impossible to obtain smooth curves. To this difficulty was added that of breaking the primary circuit in a regular manner. If the results of Table III. are plotted, it will be seen that the increase within small limits is very nearly proportional to the number of thin plates, which were $\frac{1}{16}$ of an inch in thickness.

TABLE III.

No. of Plates.	Deflection of Galv.	No. of Plates.	Deflection of Galv.
1	11	6	15
2	12	7	15.5
3	13	8	16
4	13	9	18
5	14	10	18.5

On increasing the number of plates a point was reached where there was no additional effect. The best result was obtained when the mass of the armatures was approximately equal to that of the cores of the electro-magnets. Plates of $\frac{1}{32}$ of an inch were also used, but no advantage resulted in their employment over these of $\frac{1}{16}$ of an inch. It would seem that the thin plates followed the same law as that of the bundle of fine iron wires which constitute the cores of induction coils of the present day, and that only a moderate degree of discontinuity in the mass of iron submitted to magnetic influence is necessary to prevent the formation of currents of induction, which prolong the magnetism of the cores, and prevent the quick demagnetization necessary to produce intense currents of induction. The effect of insulating the thin plates with the dielectrics was also tried with no gain in effect. There appeared to be a slight gain by placing the plates edgewise on the poles of the magnets instead of allowing them to repose on their flat faces. This was doubtless due to better contact of the metallic surfaces.

Since the above results proved conclusively a very great gain in quality and electrometric force by the application of thin plates as armatures, I next measured the striking distance of the spark. Table IV. gives the results which are the mean of many trials.

TABLE IV.

Without armatures.	With armatures
15 cm.	32 cm.
14	30
15	32
Mean, 14.5	31.3

A curious fact came to light in this connection: the lengthening of the spark was not shown when the spark leaped directly between the poles of the induction coil; the increase in quantity and electromotive force was only made manifest to the eye by the employment of condensers in the secondary circuit. The results in Table IV. were obtained by the employment of a Leyden jar of large capacity. The increase in the quantity and electromotive force was not only shown by the increased length of the spark, but also by its increase in volume, and its louder snap. The spark consisted of a thick central bolt surrounded by curious thin, detached sparks. An attempt was made to measure the increase of light in the Geissler tubes by Vierordt's photometric apparatus, but it was found too inexact for this purpose; if, indeed, there was any increase of light, which remains to be proved. I know of no results which bear upon the relation of the increase of light to the increase of electromotive force of the induction spark. Without condensers in the secondary circuit, however, the increased electromotive force of the spark was shown by its greater constancy in leaping over a given resistance of air.

Unless an instrument is desired for popular scientific lectures, length is not so much to be desired as quantity of electricity of a spark, and in this form of induction coil the gain is principally in quantity, although it is true that with the aid of Leyden jars the striking distance is increased one hundred per cent. The principal points of this paper can be thus summed up:

1. The application of thin plates of soft iron upon the poles of two straight electro-magnets, with bundles of fine iron wires for cores, increases the strength of the spark produced at the poles of the secondary coils surrounding the electro-magnets, four hundred per cent.

2. The length of the spark is increased one hundred per cent. This gain in length is only manifested by the employment of Leyden jars of large capacity, which are connected with the secondary circuit.

3. Instead of distributing the fine wire of a Ruhmkorff coil upon a straight electro-magnet, as is done at present, this wire should be distributed equally upon two straight electro-magnets, whose poles should be provided with armatures of bundles of thin plates of soft iron.

REMARKABLE PERFORMANCE OF PHELPS' NEW MOTOR PRINTERS.

WE have repeatedly mentioned the results obtained with Mr. G. M. Phelps' latest and most perfect improvement in printing telegraphs, the Motor Printers. This instrument will be a monument to Mr. Phelps' scientific and mechanical genius for all future time. It is certainly a remarkable instrument, and would seem to be the perfection of printing telegraphs.

The latest achievement with this printer exceeds anything that has ever before been accomplished, and much more than it was believed could be done, even by many of those familiar with its perfect mechanism and scientific advantages. It has been worked successfully and rapidly on a circuit of a thousand miles, without the intervention of repeaters. Recently, in order to test practically the capability of the instrument for performing what was claimed for it by the inventor, Mr. Joseph L. Edwards, of the New-York Western Union Office, one of the oldest, most experienced, and best printing telegraph operators in the country, was sent with a motor printer to Chicago. This was set up and got in working order by Mr. Edwards, and then connected with a similar instrument in New-York, and the attempt made to work in a direct circuit with New-York, a distance of 1000 miles. This was an unprecedented feat. At first the attempt was not entirely successful, but persevering in the effort, complete and satisfactory success was finally obtained. The New-York instrument was manipulated by Mr. Phelps and Mr. Gerritt Smith, the latter of whom is well known as an experienced printing telegraph operator, and an able electrician and inventor.

After the instruments had been properly adjusted, Mr. Edwards transmitted at one time a column and a half of the *New York Tribune*. A speed of fifty-six words per minute was attained, which, considering the length of the circuit, was truly remarkable.

Upon the instruments used in this test, Mr. Phelps has applied a unison stop, by which the type wheels are set at unison automatically, thus greatly reducing the tendency of the instruments to get out of synchronism, an important improvement.

Mr. Phelps is truly to be congratulated on the success which has attended his efforts to improve and perfect the printing telegraph.—*The Telegrapher.*

NEW APPARATUS FOR TRANSPORTING LIVING FISH.

M. OTTO HAINMERLE, of Dornhiche, Austria, has recently invented the improved apparatus herewith illustrated for the transportation of living fish over long distances.

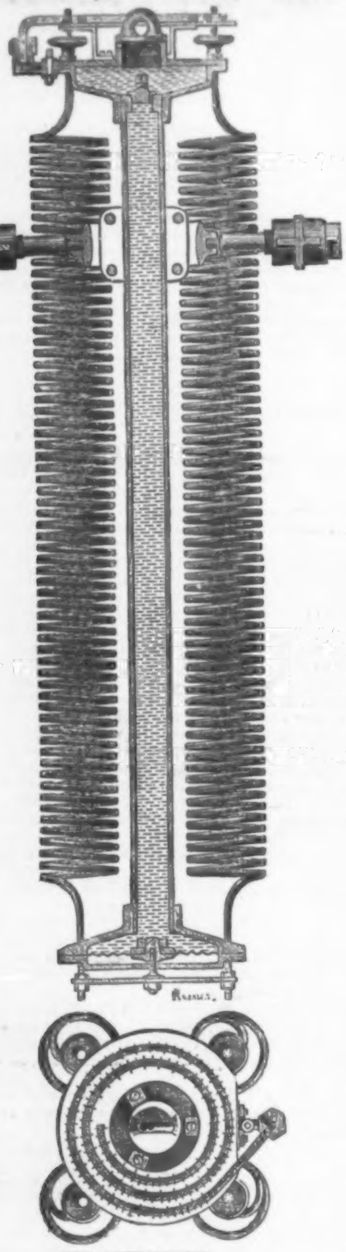
It consists of a large tank, mounted on a suitable carriage. By simple devices in connection with the running gear, the lever F is caused to oscillate and by the rod E to operate the bellows B, which after each compression is opened by the spiral spring D. The bellows forces a continuous stream of air through the siphon T and into the water of the tank through the perforated tube O. At M is a perforated receptacle for ice for cooling the water surmounted by a perforated cover. P is a filter, and N a cock for drawing off the water. G is a handle for working the bellows by hand when the vehicle is not in motion.

By regulating the device which works the bellows lever, the supply of air to the water can be increased or diminished as desired. We extract the engraving from *La Nature.*

THE BATHOMETER.

THE name "Bathometer" has been given by Dr. C. William Siemens to an instrument which he has devised for measuring the depth of sea without using the sounding line, and which has been tested in two Transatlantic voyages. The principle upon which the action of this instrument depends is the diminution of the influence of gravitation upon a weighty body, produced by a decrease in the density of the strata immediately below it; thus the density of sea water being about 1.026 and that of the solid constituents which form the crust of the earth about 2.75, it follows that an intervening depth of sea water must exercise a sensible influence upon total gravitation if measured on the surface of the sea.

The amount of this is calculated mathematically in considering the attractive value of any thin slice of substance in a plane perpendicular to the earth's radius, and assuming the earth to be a perfect sphere, unaffected by centrifugal force, and of uniform density. If h represents the vertical distance of such a slice from the point of attraction, then the differential of the attraction of each concentric ring of which such slice is composed is represented by the expression:



THE BATHOMETER.

$$d^2 A_1 = 2 \pi d h \,.\, \sin.\, a \,.\, d a \quad . \quad . \quad . \quad (1)$$

a being the angle between any ring and the vertical h, which expression when integrated between the limits h and a, and a and o, gives

$$A_1 = 2 \pi h \left(1 - \frac{2}{3}\sqrt{\frac{h}{2 R}}\right) \quad . \quad . \quad (2)$$

in which for small values of h the factor $\sqrt{\frac{h}{2 R}}$ may be neglected, when the formula assumes the form

$$A_1 = 2 \pi h \quad . \quad . \quad . \quad . \quad (3)$$

in which A_1 represents the total attraction to the depth h.

The total attraction of the whole earth is obtained in substituting R for h in (2) when the following proportion is obtained:

$$A_1 : A = 2 \pi h : \tfrac{4}{3} \pi R \text{ or } = h : \tfrac{2}{3} R.$$

It follows that if sea water was without weight, the total attraction of the earth as measured upon the sea surface, would diminish in the proportion of the depth to $\frac{2}{3}$ R; but taking the weight of sea water into account, gravity is found to diminish upon the sea level in the proportion of the depth to $\frac{12}{15}$ R or as .8 R, this proportion would be strictly correct if the interior of the earth was of the same density as surface rock, but the coefficient here arrived at has to be diminished in the proportion of the density of surface rock to the mean density of the earth or in the proportion of about $\frac{2.75}{5.4}$. It is safer, however, not to rely entirely upon these mathematical deductions in constructing a working scale, which it is preferable to base upon comparison with the sounding line.

Within the last year, the exigencies of deep-sea telegraph construction have shown the value, and indeed almost the necessity, of having a depth indicator always to hand, and hence the instrument of which we give a diagram to our readers, not showing details, but only the principle of action.

It consists essentially of a vertical column of mercury contained in a vertical steel tube having cup-like extensions. The lower portion is closed by means of a corrugated steel plate diaphragm, similar in construction to those employed in aneroid barometers and the weight of the mercury is balanced in the centre of the diaphragm, by the elastic force of carefully tempered steel springs whose length is the same as that of the mercury column. Both ends of the column are open to the atmosphere, so that its variations of pressure do not affect the readings of the instrument.

The elasticity of carefully tempered steel springs having been found by experiment to diminish in an arithmetical ratio with rise of temperature, but in a different ratio to that of the dilatation and consequent diminution of the density of mercury, this had to be arranged for in the mechanical arrangement of the instrument. It is evident that if the mercury were contained in a cylindrical vessel not varying in diameter, its potential would always be sensibly constant. If, on the other hand, two cups were connected by a tube of infinitely small diameter, the potential would diminish with rise of temperature in the ratio of the expansion of mercury. The form employed in the instrument is a mean between these extreme forms, the ratio between the areas of the cups and that of the tube being governed by that of the diminution of the density of the mercury and potential of the springs.

The tube is throttled near its upper extremity, in order to diminish the influence of the ship's motion in causing vertical oscillations of the mercury. The instrument is suspended in a universal joint, a short distance above its centre of gravity, in order to cause it to retain a vertical position notwithstanding the oscillations of the vessel, and it is contained in an air-tight casing so as to be unaffected by atmospheric influences.

The reading of the instrument was effected by means of electric contact between the centre of the diaphragm and the end of a micrometer screw, the divisions on the rim and the pitch of the screw being so proportioned, that each division represents one fathom of depth. Another mode of reading the instrument by means of a spiral glass tube fixed on the top of the instrument, and connected with the mercury in the upper cup by means of a liquid of less density, is now employed, and has been found to be successful in practice.

The indications of this instrument have been compared with soundings taken by means of Sir William Thomson's steel-wire apparatus, and show a very close accordance. The following shows what kind of indications it has given. On the 31st of October, 1875, according to soundings the Faraday was at noon in 82 fathoms, at 1.8 P.M. in 204 fathoms, and at 2.20 P.M. in 69 fathoms of water, whilst the bathometer readings were 82, 218, and 78, showing that the instrument indicated a passage from shallow into deep water and back into shallow in a period of two hours with considerable accuracy.

The instrument is also applicable for measuring heights above the surface of the earth, such as balloon ascents, but its indications of the height of mountains or elevated plateaus would be affected by the attraction of the elevated land, varying with its surface, and the instrument is not therefore considered reliable for such purposes. In the use of this instrument, the chief disturbing influence is the effect of variation of latitude upon the earth's attraction, varying as the square of the sine of the latitude, the difference between the equatorial and polar attraction as established by pendulum observation being $\frac{1}{190}$th of the former. The amount of this correction would be calculated as depth in fathoms and tabulated for use with the instrument.

The instrument would be chiefly useful in enabling the mariner to determine his position, when in foggy or cloudy weather he was unable to take observations. If the figure of the ocean bed was laid down more perfectly than at present upon charts, and such were in the hands of the mariner, he would be able to tell in observing his bathometer what was the approximate depth of water below him, and the direction in which, and the rate at which the depth either increased or diminished, while by consulting his chart he would then be enabled to determine his actual position with considerable accuracy.—*Engineering.*

CURIOUS MARINE ANIMALS.

THE annexed engravings, taken from *La Nature*, represent three of the most curious of the low order of animal life which dwells in the ocean depths. The fan-like creature shown in Fig. 1 is called the sea-brush, and belongs to the genus *Sabellidæ*. It lives in gelatinous tubes covered with sand, and spreads forth its filaments either in fan or spiral shape. Of the tentacles one is usually much thickened so as to form a sort of plug, which closes the aperture of the tube when the animal is retracted. The genus is quite numerous in species, which are commonly divided into two groups—one having two ranges of tentacles, the other, which is the group here illustrated, having in connection with its respiratory filaments but a single range. The *Sabellidæ* are found in great quantities on the shores of the Mediterranean, and their tubes are frequently fixed on the soil beneath a kind of sea-weed, which is commonly used and sold under the name of vegetable horse-hair.

Fig. 2 is a curious polypidon belonging to the genus *Veretillum cynomorium*. The polypes occupy the anterior portion of the body and the base remains naked. It is found in the Indian Ocean, and often attains a length of thirty centimetres. It is a floating zoophyte, and has the property of yielding a fine phosphorescent light. The body is very simple, and allows of the study of the intestinal portions with greater facility than is possible in any other class of composite zoophyte.

The Stephanomia and Apolemia are strange creatures, allied to the jelly-fish, which have recently been studied by M. Vogt. These animals are exceedingly complicated. The large or including individual produces from the bottom of its cavity a slender stalk which is continually increasing in length, and from which new polypes are produced at the portion nearest the original polype. In this manner a chain of polypes is formed, each presenting a considerable resemblance to its original parent, and each also exerting a certain degree of independent movement; although the superior power of the large parent animal always determines the direction in which the whole mass shall move through the water.

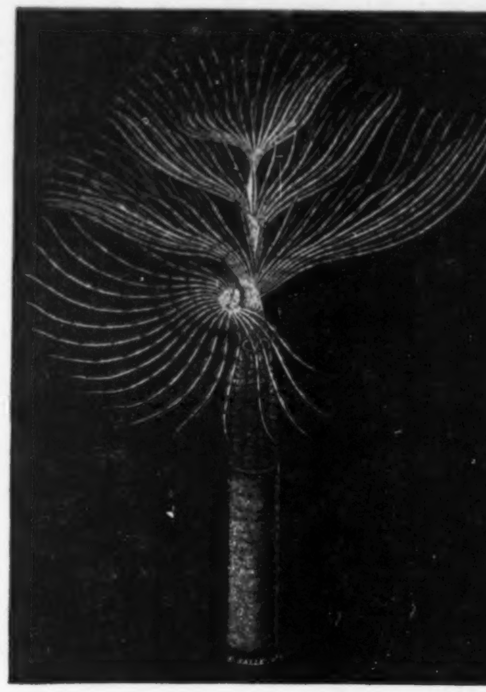


FIG. 1.

In the *Apolemia* (Fig. 3) this complication becomes extraordinary. The colors of the various members of the chain are brilliant purple and orange, and the long clusters found in the Mediterranean, sometimes exceeding a metre in length, resemble exquisite garlands of flowers. The polypes are delicately fragile, and seem to be mere bubbles, although they are living creatures. In Fig. 3 at a are shown the swimming organs; $b\,b$ are the nourishing animals, which are provided with mouths, and which fulfil the office of receiving food for the entire colony; c are members without mouths, but having apparently eggs and the reproductive faculty; $d\,d$ are tentacles for catching prey, and also possessing considerable urticating power.

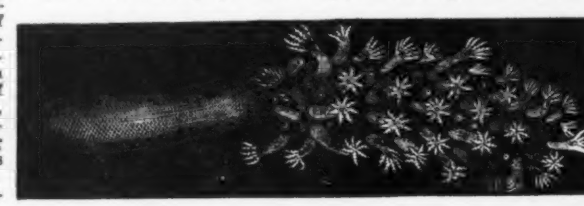


FIG. 2.

FIG. 3.